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ABSTRACT

Resource-based learning is described in this document as a pupil-centered approach to teaching science in which a wide variety of resources are used. Students are given some freedom of pace and choice of activity while teachers provide resources to the student when they are needed. The learning is then based on the resources and the pupil can make as much use of them as his/her abilities and interests dictate. The booklet was developed to assist teachers in: (1) deciding if resource-based learning is feasible for their teaching situation; (2) deciding which model of resource-based learning would best fit their needs (should they decide it is feasible); (3) producing course materials which are organized and manageable; and (4) implementing a resource-based learning program. Included are five case studies from Scottish high schools which use a resource-based approach to learning. Two of the case studies are examples of resource-based approaches to teaching physics, one deals with chemistry, one with biology, and the last one is used in an integrated science course. The appendices include a register of resource-based science courses in Scottish secondary schools and a bibliography. (TW)

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Consultative Committee on the Curriculum

Scottish Curriculum Development Service

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RESOURCE BASED LEARNING

SE 047 857

MEMORANDUM NUMBER 64

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October 1984

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PREFACE

There exists at present a great deal of interest among science teachers about resource-based learning. What is it? What are its implications? How might a teacher set about it?

A considerable number of teachers are known to be experimenting and gaining experience in this area of development and there was seen to be advantage in disseminating the fruits of this experience in the form of a memorandum. Such a memorandum could also prove useful in the Munn-Dunning context where the possibility exists that some teachers in smaller schools may be faced with some degree of composite classes.

The Scottish Central Committee on Science invited Dr E Hay (Moray House College of Education) and Mr R Dawson (Adviser, Lothian Regional Council) to gather, collate, comment on and edit information in order to produce such guidance.

Those who participated in the production of Case Studies for this Memorandum were:-

Mr J Boyd, APT Science, Holy Rood High School, Edinburgh

Mr J Goodfellow, PT Chemistry, North Berwick High School, N Berwick

Mrs D Lukowiecki, PT Biology, St Augustine's (RC) High School, Edinburgh

Mr B McIntosh, PT Physics, The James Young High School, Livingston

Mr A Steven, PT Physics, Wester Hailes Education Centre, Edinburgh

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Introduction

This Memorandum on Resource-based Learning (RBL) can be seen as recognition of the school-based developments that have taken place in Scotland over the past decade. RBL itself has a long history but its development has now become much more widespread and sustained.

The main aim of this Memorandum is to describe the experience of others in a way that will provide useful support to departments or individual teachers contemplating a move towards RBL. Experience has shown that the success of such developments can depend critically on the planning and discussion that precedes implementation. Thus the emphasis will be very much on providing pointers regarding the management of the change. The following pages may also provide a useful outline introduction to RBL but this cannot replace the need for extended in-service courses and active links between schools within LEAs.

The essence of such developments during the Seventies and Eighties has been a questioning of the traditional pattern of whole-class teaching. For some teachers dissatisfaction with existing classroom practice and the rather limited learning experience being offered to pupils was a major incentive to change. Present national developments both for 14-16 and also 16-18 are giving additional momentum to existing trends.†

There thus exists a range of pressures both internal to the classroom and external to the school that require a greater flexibility in the teaching and learning process than appears possible when whole-class teaching is allowed to dominate classroom organisation. Where change has taken place, the result has been an amalgam of individualised, small-group and whole-class work allowing varying degrees of self-pacing and variation of content. All systems differ. Such essential differences simply reflect the variations between subjects, pupils, teachers and the resource provision available at a particular time.

What is RBL?

For those readers of the Memorandum who are less familiar with RBL methods, it may be helpful to review some of the terms currently applied to teaching methods which employ a more pupil-centred approach. These include

- individualised learning
- independent learning
- resource-based learning

†See Appendix 1.

Individualised learning. In courses labelled as 'individualised', recognition is given to the needs of each pupil in terms of his particular abilities, background and interests. The course is planned by the teacher with these needs in mind rather than for a whole class working as a single unit. This does not necessarily mean, as is often inferred, that the pupil must work alone throughout the whole course. What it does mean is more freedom of pace and choice of activity for the pupil. At times he may work alone, but mostly he will work with another pupil or with small groups of pupils who, at that time, are at the same point in course work. The composition and size of these groups will change with the individual pupil's progress through the course. Thus he has the stimulus of inter-action with his peers, but much of his inter-action with his teacher will be on a 1:1 basis, that is he is treated as an individual.

Independent learning. By definition, this term infers that the pupil is responsible for planning his own course of study and consequently is not relying on his teacher, This situation is quite distinct from that of individualised learning where the whole course structure has been planned by the teacher and although the pupil may follow his own route through the course, he is dependent on his teacher for the provision of the learning materials and for guidance. The nearest approach to independent learning in a school course is probably project work, but even then the teacher is in the background as guide and supervisor.

Resource-based learning. All teachers, whatever their teaching methods, use a wide variety of resources. It is the way in which these resources are deployed which distinguishes whole-class, lock-step teaching from pupil-centred learning. If pupils are to be given some freedom of pace and choice of activity then resources must be placed at their disposal as and when they will need them; that is, as the term implies, the learning is based on the resources. They are there for the pupil to make as much use of as his abilities and interests dictate.

As can be seen from the above, individualised learning and resource-based learning are closely inter-connected. In both there is some degree of self-pacing and choice of activity for the pupil. In an RBL course, however, a variety of methods may be employed ranging from fully individualised units to whole-class teaching where this may be considered more appropriate. The essence of such a course is variety and flexibility.

Justifications for a move towards RBL

There is no denying that the introduction of RBL involves much work for the teacher. The only justification for this lies in a perceived improvement of the learning environment for both pupil and teacher. The Case Studies speak for themselves in this; although difficulties are not minimised, a spirit of enthusiasm for RBL pervades the writers' accounts of their experiences.

Ample evidence of gains for pupil and teacher resulting from RBL is to be found both in the Case Studies and in the literature references given in the bibliography. The main advantages claimed for the method are summarised below. This summary may serve as a check-list for the reader in his further reading.

- There is a reduction in frustration for pupils at each end of the ability spectrum. The more able are not held back; the less able have time to complete each piece of work without the growing dissatisfaction of continually being moved on from one incompletely understood topic to another.

- There is an increased opportunity for individual contact between pupil and teacher in a more informal setting. This means that help can be given at the point when it is most needed; not too soon when explanations fall on closed ears, nor too late when explanations are superfluous. The teacher more quickly identifies areas where a pupil is experiencing difficulties and is able to take remedial action before it is too late.

- The reduction in frustration and the closer individual relationship with the teacher result in a lessening of discipline problems. Other factors apart, the disruptive pupil no longer has an audience for a confrontation with the teacher as other pupils are too preoccupied with their own affairs to notice him. Diffident pupils are readier to reveal their difficulties to the teacher if they can do so out of earshot of their peers; likewise praise is more readily accepted.

- The confidence and skill with which pupils carry out practical work improves, as does their ability to make use of resource materials. These outcomes are particularly desirable in the light of the increased emphasis given to these skills in the recent course developments in Scotland.

- Overall the acceptance by the pupil of greater responsibility for his learning brings benefits with it for the pupil and his teacher.

Management of the Change

When the staff of a department decide on the introduction of RBL it is essential that they are fully aware of the commitment into which they are entering. The ultimate success of the course is largely determined by the planning and discussion which precede its implementation.

This Memorandum is designed to assist the reader in coming to a decision; firstly, on the feasibility of introducing RBL and then, if he decides to proceed, on the model which would best suit his needs.

There is a wide field of experience on which to draw (Appendix II, RBL Register). To some extent the experience of each school is unique with regard to its needs, facilities and environment, but common features do exist at each stage of course development. These have been identified and are set out in flow diagram format (pp 5-8).

In the flow diagrams the processes of planning, developing and implementing RBL have been ordered into four phases.

Phase 1 A Change in Teaching Method?

Phase 2 Is RBL feasible?

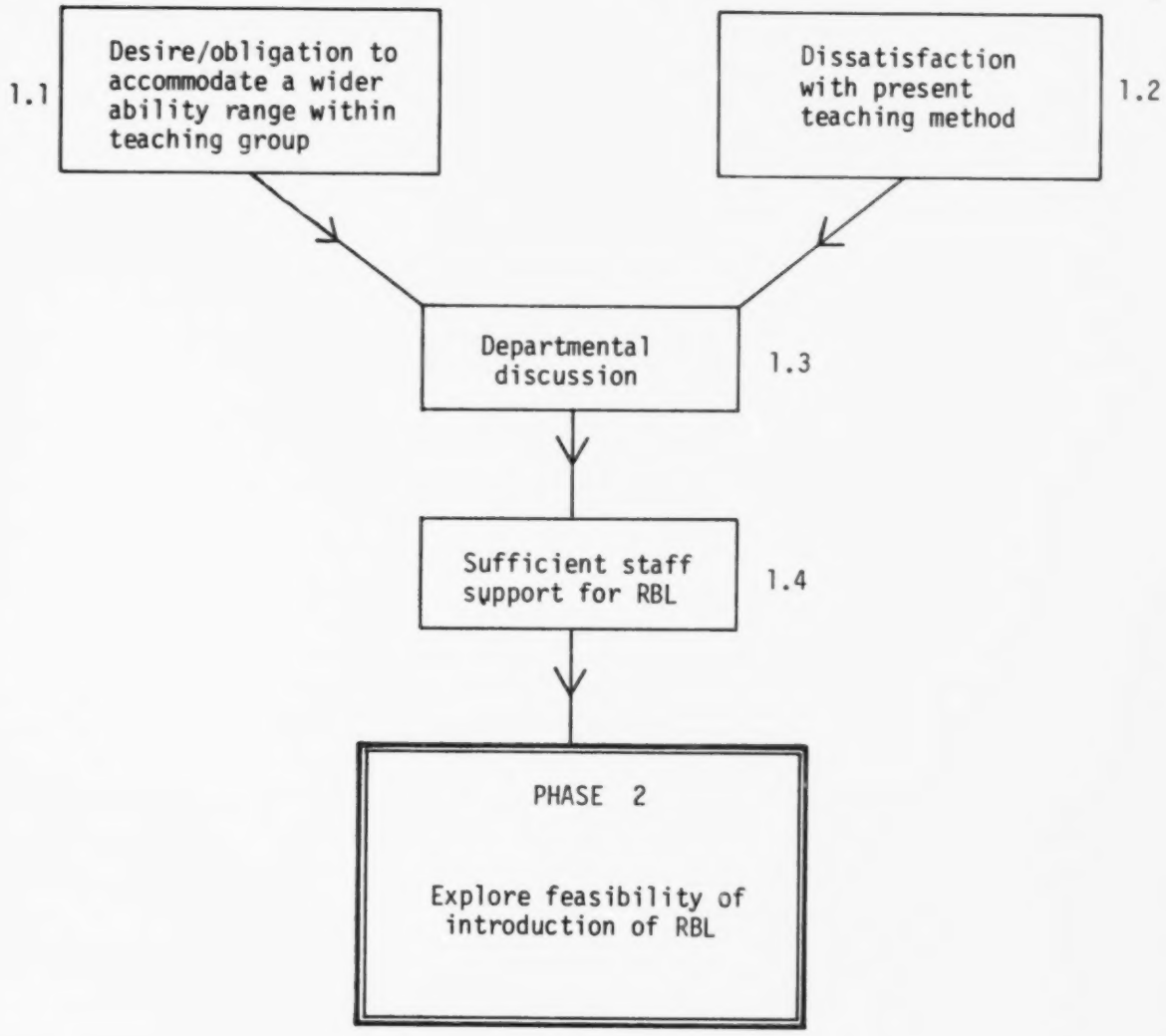
Phase 3 Producing the Course Materials: Organisation and Management

Phase 4 Implementation

The flow diagrams, by providing an overview of the management of the change to RBL, may serve as a basis for departmental discussion.

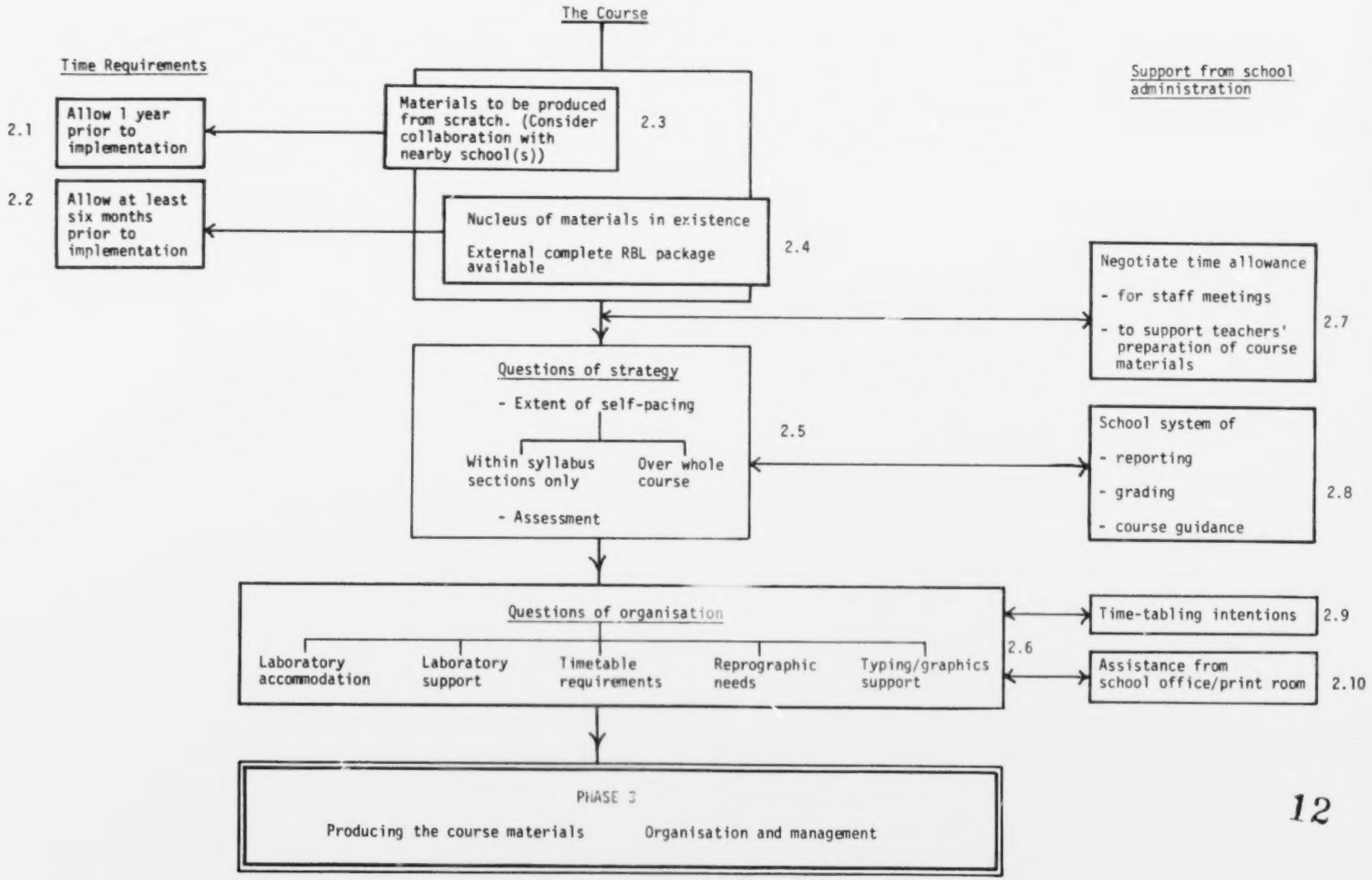
It is intended that the flow diagrams be used in conjunction with the case studies (pp 11-58) in each of which the particular experience of one school is described. To facilitate the inter-linking of flow diagrams and case studies the steps within each phase are indexed and cross-references to these are given in the case studies. By this means the reader may readily locate those details of planning and implementation which are of particular interest to him.

PHASE 1 A CHANGE IN TEACHING METHOD ?

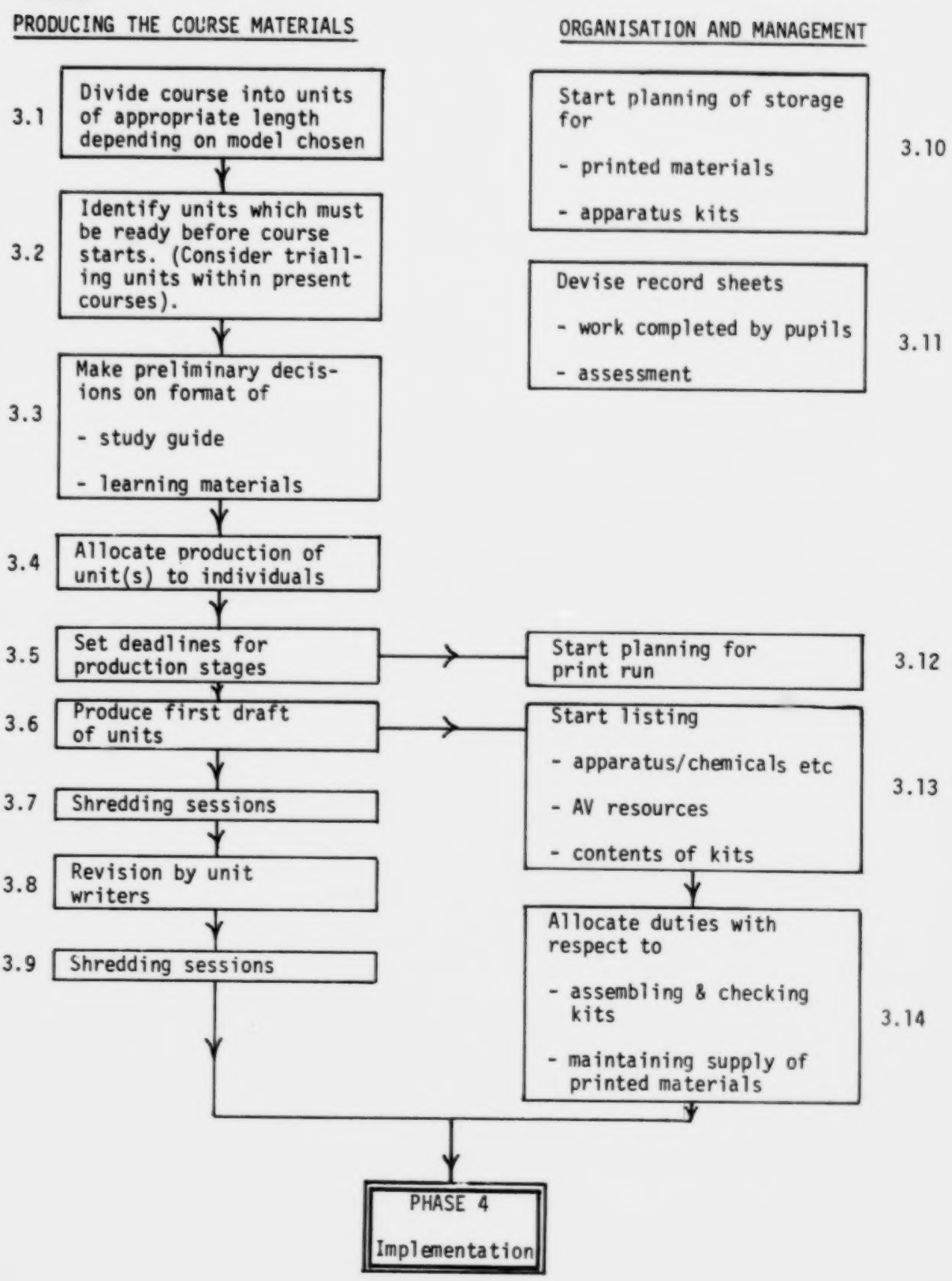


PHASE 2

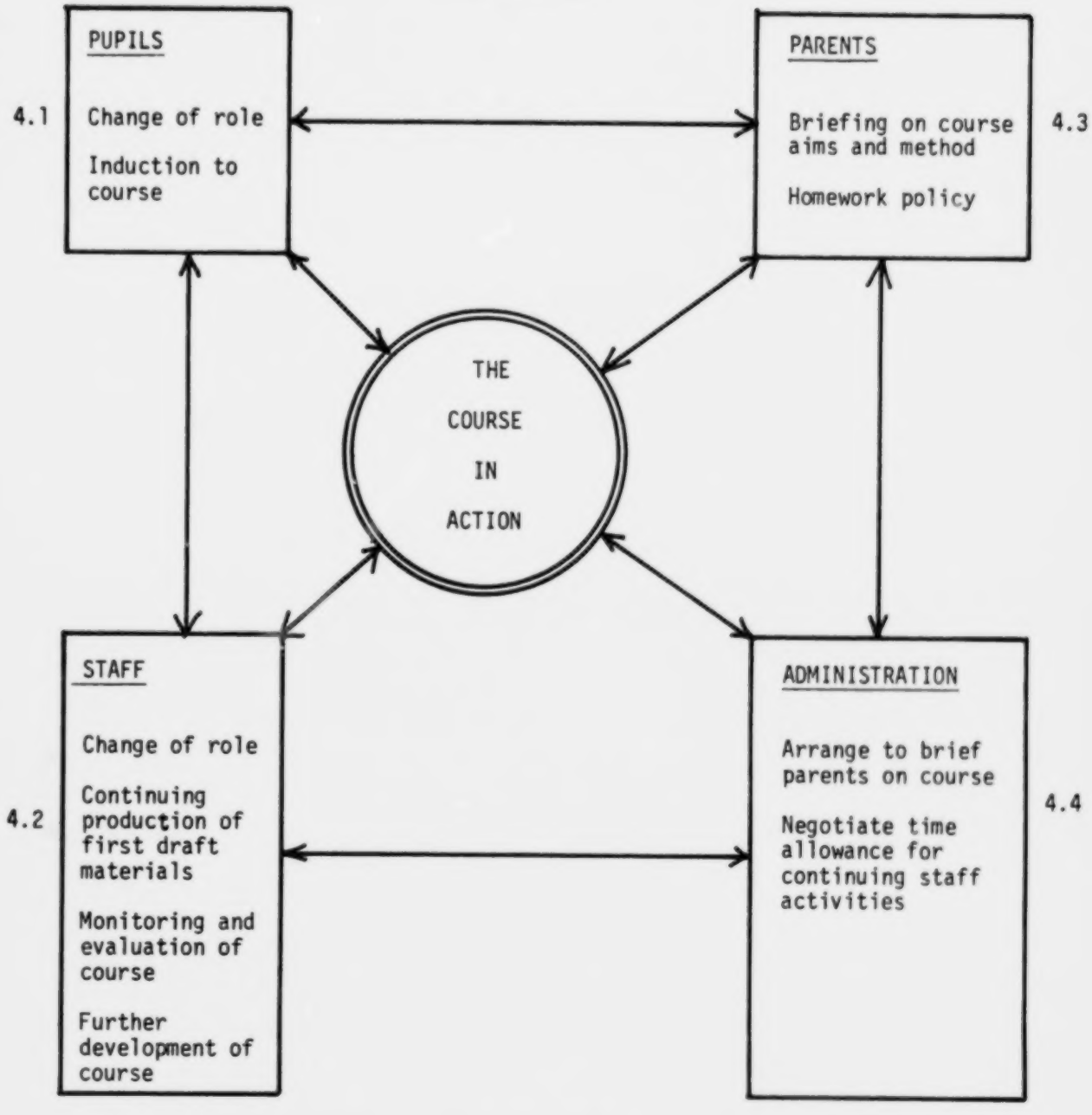
IS RBL FEASIBLE ?



PHASE 3


PRODUCING THE COURSE MATERIALS
ORGANISATION AND MANAGEMENT
3.1 Divide course into units of appropriate length depending on model chosen
3.2 Identify units which must be ready before course starts. (Consider trialling units within present courses).
3.3 Make preliminary decisions on format of
- study guide
- learning materials
3.4 Allocate production of unit(s) to individuals
3.5 Set deadlines for production stages
3.6 Produce first draft of units
3.7 Shredding sessions
3.8 Revision by unit writers
3.9 Shredding sessions
3.10 Start planning of storage for
- printed materials
- apparatus kits
3.11 Devise record sheets
- work completed by pupils
- assessment
3.12 Start planning for print run
3.13 Start listing
- apparatus/chemicals etc
- AV resources
- contents of kits
3.14 Allocate duties with respect to
- assembling & checking kits
- maintaining supply of printed materials
PHASE 4
Implementation

PHASE 4 IMPLEMENTATION



The Case Studies

School	Year	Course	Page
The James Young High School	S3/4	Physics	11
St Augustine's High School	S3/4	Biology	20
Wester Hailes Education Centre	S3/4	Physics	29
North Berwick High School	S3/4	Chemistry	38
Holy Rood High School	S1/2	Integrated Science	44

Phase 1

A Change in Teaching Method?

"The decision to develop this course arose from the realisation that the ability range of pupils opting to study the subject was very wide".

Phase 2

Is RBL feasible?

"A great deal of time must be given to careful thinking, discussion and production of materials. This requires total commitment from the staff involved. There can be no half-hearted attempts".

Phase 3

Producing the Course Materials

"The teacher must have a masochistic trait to enable him to write the materials in time for next term...".

"Having only one full-time technician within the science department meant that the course had to be designed and run with the minimum of auxiliary help".

Organisation and Management

Phase 4

Implementation

"...our new format...has improved pupil interest and motivation. It has also improved teacher motivation".

"The feedback from parents was favourable".

"There is a continuing commitment to the development of the course".

"With our present more limited resources we are considering the possiblitiy of a less ambitious system of RBL which can still be expected to produce many of the advantages of more sophisticated patterns of organisation".

"The pupil who feels successful will also feel happy".

S3/4 Physics at The James Young High School

Reasons for Introduction of Course

James Young High School opened in 1982. The decision to introduce RBL from the outset in S3-4 Physics was made for a number of reasons.

Codings cross-reference to Flow Diagrams (pp 5-8)

1.1 (i) The course was to be offered to a wider range of abilities than would traditionally start an '0' Grade physics course; awards were to be given at CSE level as well as at '0' Grade.

1.4 (ii) Some of the staff had previous experience of RBL and believed it to have advantages for the pupils, namely:-

- pupils are encouraged to be more independent
- pupils of different abilities could work at their own pace and level
- absent pupils would not 'miss' any work but would simply pick up where they left off

and, additionally, there is no need for class sets of equipment and greater use is made of each piece of equipment.

(iii) The opportunity existed for collaboration in the production of course materials with staff at St Augustine's High School, Edinburgh.

Planning Time 2.2 Initial planning started twelve months before implementation and writing started six months ahead.

2.4 The course was developed from one which had been started at St Augustine's High School in 1974 and the materials were written by two teachers from James Young High School in collaboration with two teachers from St Augustine's.

Strategy The original model developed at St Augustine's was linear and completely self-paced. There were 30 units in the two year course. Inadequacies were found in the system

- the units were aimed at the average pupil and did little for the less able; some pupils had 'dropped out' of '0' Grade physics by Christmas in S3
- the brightest pupils went through the units too quickly and in consequence they were often completely out of step with lectures/demonstrations and needed equipment which was not ready for them. Several pupils regarded the course as a race and rushed to be first finished, learning only the minimum on the way.

We saw these points as being an indication that changes were needed, but our basic faith in RBL was still intact.

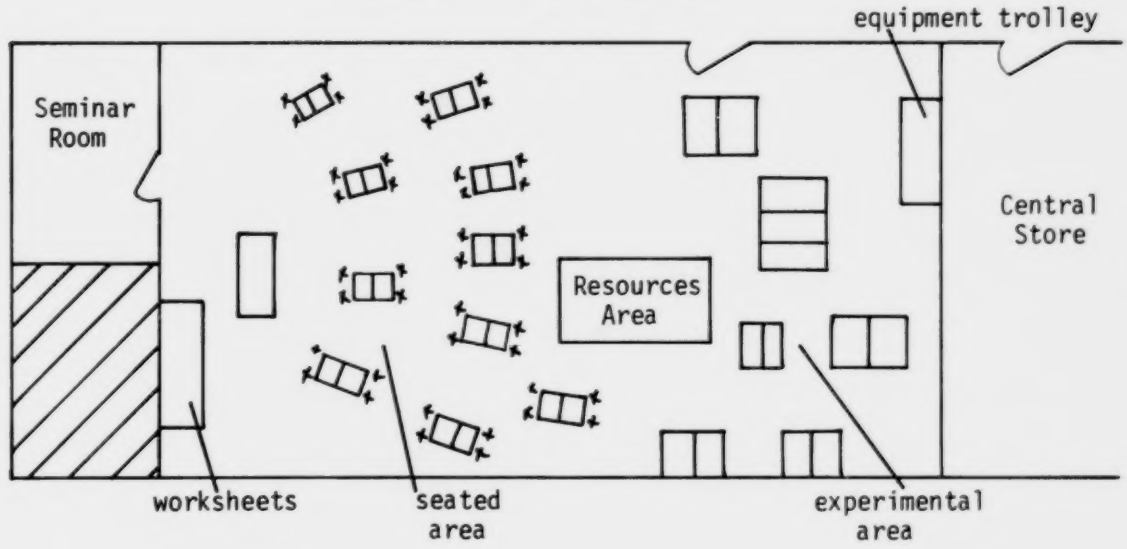
2.5 In the present course each unit is self-paced, but all pupils finish the unit on the same target date.

Organisation

Having only one full-time technician within the science department meant that the course had to be designed and run with the minimum of auxiliary help.

2.6 This course is taught in a double laboratory (maximum class size 40 pupils) with mobile services and a small seminar room (Fig 1).

Fig 1 - Plan of Department



2.9 To make team-teaching feasible the school management agreed to timetable S3 and S4 Physics in double classes and it was also accepted that mixed CSE/'O' Grade classes could be formed.

2.6 Each teacher does his own typing and graphics but assistance is given by the school office in providing reprographic
2.10 facilities (off-set litho) operated by the office staff.

Course Materials

3.1 The course consists of 20 units made up of core material and two levels of extensions in which the lower level of extension mainly reinforces the core and the higher level takes the core work as the starting point for more difficult work.

Pupils completing mainly core and lower level extensions would probably not be presented for 'O' Grade but would be awarded a CSE. The final decision on CSE or 'O' is

deferred until the end of third year. It is hoped that the course will transfer to General/Credit without too many changes.

Each unit is self-paced, but all pupils finish the unit on the same target date, the date being set as the unit progresses. Some pupils complete only the core; some complete the core and all the appropriate extensions. The majority complete the core and some extensions.

The materials used

3.3 Each worksheet (or study guide) has a range of activities and may include:-

1. reading from a textbook and making notes
2. reading from a small topic booklet or poster
3. experiments
4. demonstrations
5. slide or video viewing
6. practical investigations
7. numerical problems
8. short answer questions
9. discussing
10. games/simulations

These worksheets are re-usable.

In addition, for each unit, pupils get a homework sheet and a unit cover. Both are consumable.

The unit cover lists the titles of all the worksheets and includes 'credit points' which the teacher signs to indicate that a particular worksheet has been satisfactorily completed. The back of the cover has a list of all the unit objectives. These are grouped as core objectives and extension objectives and are written in language which pupils will understand.

3.11 For recording purposes the pupil keeps a note on his unit cover and the teacher has a grid for each class (Fig 2).

Block 2 (Waves) LIGHT/WATER WAVES/SOUND Teacher McIntosh

NAME	4·1	4·2	4·3	4·4	4·5	CORE TEST	5·1	5·2	5·3	5·4	5·5	L.S.S.	CORE TEST	6·1	6·2	6·3	CORE TEST		BLOCK TEST CORE	BLOCK TEST EXT.		INK EXER.
David	c ✓	g ✓	c ✓	c ✓	c ✓	14/15	c ✓	✓	c ✓	g/c ✓	c ✓	✓	19/20	c ✓	c ✓	c ✓	19		99%	73%		
Archie	g ✓	g ✓	c ✓	c ✓	c ✓	13½	c ✓	✓	c ✓	g/c ✓	g/c ✓	✓	14½	g/c ✓	c ✓	c ✓	13½		59	27		
David	c ✓	g ✓	c ✓	c ✓	c ✓	15	c ✓	✓	c ✓	c ✓	c ✓	✓	20	c ✓	c ✓	c ✓	19		93	90		
Cameron	g ✓	c ✓	c ✓	c ✓	c ✓	14½	c ✓	✓	g/c ✓	g/c ✓	g/c ✓	✓	18	c ✓	c ✓	g/c	14		89	52		
Pamela	g/c ✓	o	g	c ✓	✓	11½	g	g ✓	g/c ✓	c ✓		✓	14½	c ✓	c ✓	c ✓	14½		79	35		
Elizabeth-Ann	c ✓	c ✓	c ✓	c ✓	✓	13½	g	g ✓	c ✓	c ✓		✓	19½	c ✓	c ✓	c ✓	18		90	80		
Tracy	c ✓	c ✓	c ✓	c ✓	c ✓	14	g	g ✓	g/c ✓	c ✓		✓	16	c ✓	c ✓	c ✓	18½		86	63		

Have you checked homework log recently?

Fig 2 Teacher's Record Grid (3.11)

Key

Core sheet grading

General/CSE extension

Credit/'O' extension

No extension at this level available

g — Core work graded at General/CSE standard. The corresponding extension is then allocated

c — Core work graded at Credit/'O' standard. The corresponding extension is then allocated

c ✓ — Extension corrected

L.S.S. ✓ — Lecture sheet summary has been completed

Writing Worksheets

3.4 At an initial meeting the work of a unit is divided among the writers. During the next two weeks they write their core and extension sheets and present them for shredding at the next meeting.

3.5

3.6

3.7 Our experience has been that the most time-consuming part of writing or shredding worksheets is trying to find a simple way of saying things; it is not uncommon for two or three people to spend fifteen minutes trying to phrase one sentence. But this usually turns out to be time well spent for, if a compromise is made and something produced which can be misunderstood, the inevitable consequence is that the teacher must ultimately explain it to each individual pupil.

It is often soul-destroying to have 'your' worksheet torn to pieces by colleagues, but this is a feeling which is overcome when it is seen that the finished product is an improvement on the original.

Remedial help

Presently, we have only one remedial teacher for the whole school. He does very valuable work with S1/2 Science and Foundation Science but is not available to help in S3/4 Physics classes. However, he does read through some of the worksheets and advises on structure and layout.

Laboratory Organisation

Storage and Distribution Software

3.10 Initially pupil worksheets were stored loose in bankers boxes and pupils collected and returned the sheets. However, in a short time the sheets became crumpled and tattered. Now a 'book' is made up consisting of a cardboard cover and all the worksheets for the unit.

The cover is numbered and each pupil has his own book. This method is much more satisfactory for fewer sheets disappear and they are kept in good condition.

When a unit is completed the worksheets are stored, along with the masters, in a filing cabinet.

Textbooks are stored in a resources area in the middle of the laboratory and are taken out when needed. Books may be taken home at any time on a library basis.

Booklets and individual resource sheets are stored in a magazine rack.

Hardware

The double laboratory is kitted out with basic laboratory hardware, i.e. bunsens, lab packs, metre sticks etc. The specialist equipment for each unit is stored on a trolley.

3.10 Organisation of apparatus

Less equipment is needed using RBL since class sets are no longer necessary. However, each piece of equipment is used more and this may reduce its lifespan. Pupils have more 'freedom' with the equipment and this may lead to more 'accidents'.

Small equipment e.g. crocodile clips, lenses, mirrors, should be stored on a trolley in such a way that their numbers can be checked quickly at the end of the lesson.

Most large pieces of equipment have an Apparatus Card which explains exactly what to do and the safety measures to be taken.

Inevitably giving pupils greater freedom with equipment leads to more breakdowns, but well-written Apparatus Cards can usually avoid the problem.

Any dangerous, complicated or expensive apparatus is demonstrated e.g. radioactivity apparatus, thermionic diodes etc.

3.14 As the work of a unit nears completion, the technician goes through the next unit, notes the equipment needed and makes
3.13 up the next trolley. This requires, on average, four hours work every four weeks or so.

Costs

At the beginning there is a large outlay, mainly on paper and printing. However 80-90% of the sheets are re-usable and so this cost reduces after the initial period. Less money is spent on hardware.

Implementation

The Course in Action

Induction

Pupils who have experienced RBL in S1/2 need only a minimum of guidance at the start of the course. (See also 'Staff and pupil attitudes to the course' p 18).

4.1 All pupils are issued with an introduction to the course which includes

1. a list of the unit titles and approximate target dates for completing each block of units.

2. a list of keywords which will guide them through the worksheets, also the colour code of the worksheets.

3. an explanation of the format of the course i.e. core plus extensions.

4. an information sheet on Study Techniques.

4.2 Role of Staff

In the double laboratory we do team teaching. One teacher marks work while the other helps with experiments etc. During the double period these roles may change several times.

Aspects of experimental work

Generally each unit starts with a piece of reading followed by an experiment. This is deliberate policy since starting experiments immediately would result in all the pupils wanting to use the same apparatus at the same time.

4.1

During experiments pupils generally work in pairs. Although the course is self-paced, friends tend to work at the same rate so that they can do the experiments together. However, experimental groups often change.

We have found that pupils are able to handle equipment more confidently and that they have a greater understanding of its function.

Development of language skills

Throughout the course we have tried to develop language skills with particular emphasis on note-making and the writing up of experiments. Both these activities are started in S1/2 but the pupils' performance in them is generally still unsatisfactory at the start of S3.

4.1 We develop note-making skills in the following way. Initially pupils simply read the textbook and then fill in blanks in a summary which they have copied out. At the next stage they put together highlighted phrases, then produce notes from highlighted headings and keywords. Finally, they are simply given a heading and a book; no page reference is given, pupils are expected to find the appropriate section by use of the index.

Assessment Pattern

Each unit lasts about four weeks and both pupil and teacher keep a record of which sheets have been completed. There is a test, assessing core objectives only, at the end of each unit which all pupils sit at the same time. The test results can be used to decide which level of extension the pupil should attempt.

4.1 At the end of each block of units (a block is usually three or four units) pupils sit a Block Test. There are two sections in the test. The first assesses core objectives and lower level extensions (the CSE test meantime, the General later) and the second section assesses all the objectives (the 'O' Grade test meantime, the Credit later).

Various types of question are set in the Block Test e.g multiple choice, short answer, numerical, graphical, complete 'O' Grade 10 mark questions etc.

Questions set in the Unit Test tend to be knowledge/ comprehension types and are criterion-referenced.

Briefing of parents

4.3 At the start of the S3 course an introductory note was given to pupils and parents explaining the system. The feedback from parents at parents' nights was favourable. As the course proceeds, reports are sent to parents giving the core test marks and the percentage mark on the two Block Tests. These may be accompanied by some general comments.

Staff and pupil attitudes to the course

Both staff and pupils found some problems initially, particularly on the administration side e.g. in remembering which jotter was for experiments, where the next worksheet was kept and where equipment was stored.

The first S3 to go through the course had not experienced any individualised learning in S1/2 and several of these pupils felt that RBL was a licence to do nothing and that no-one would notice. This is not the case since such pupils can be identified very quickly on the teacher's record grid (Fig 2, p 14).

The next S3 group had already experienced RBL and they settled into the course much faster.

4.1 It has been claimed by the critics of RBL that pupils become bored, that the more able are not stretched and that the less able are confused. We have found that variety of presentation, with the occasional 'fun' item, is the answer to boredom. If worksheets have the same format all the time the pupils do become bored. Our most able pupils work through the core quickly but they are adequately stretched on extension work. The less able take some time to get used to the system and may 'switch off'. It is important that the core material should be written in such a way that the least able pupil will achieve some success and, thereby, encouragement.

4.2 For the teacher the production of materials is very time-consuming. Organising meetings is difficult and sometimes the teacher feels he is getting nowhere. However, the reward comes when teaching the materials. If the worksheets are well written then pupils need only a minimum of guidance. Some critics say that the teacher becomes a marking machine but this should not be the case for the course can be organised in such a way that pupils do a certain amount of self-marking. The teacher should find that his time is spent mainly with pupils who are having difficulties.

4.4 There is a continuing time commitment to the development of the course. We estimate this to be about four hours per week for each teacher plus a group meeting every three weeks. These meetings take place in school time if possible, but usually they must be held in the evenings.

Our plans for future development include the introduction of practical assessment along the lines of the TAPS project, and of practical investigations. We shall also be exploring the use of computers both as a teaching aid and for assessment purposes.

S3/4 Biology at St Augustine's High School

Reasons for introduction of course

RBL has been used in various forms by all 3 departments in Science since 1975. Since the initial development various problems have arisen and the initial shortcomings of the original courses have been noted and acted upon.

1.1, 1.2

The original materials developed were based solely on the total 'O' Grade syllabus and all pupils were presented with the same materials and were expected to achieve the same learning outcomes. Over a period of about three years it became increasingly apparent that as far as biology was concerned this was a totally unsatisfactory approach as the majority of pupils were really of a "CSE" standard. Over the last two years the present model has been developed to satisfy the demands and abilities of all pupils entering biology in their third year.

Planning time

2.4

We have tried to use the 'O' Grade syllabus in a manner which makes biology more relevant to the pupils' every-day life. Rather than deal with it on a purely theoretical basis, we have tried to apply it to life and their experiences wherever possible. For this reason we have built in general interest extensions which may cover topics not included in the 'O' Grade syllabus. Also, in some cases, we have omitted those parts of the syllabus which we consider to be too theoretical or lacking in real relevance. If biology, and in particular RBL biology, is to be successful, interesting and relevant, the materials produced for use by the pupils must be of a high standard in relevance, presentation and variety of activity.

1.3, 1.4

This requires total commitment from the staff involved. There can be no half-hearted attempts. A great deal of time will need to be devoted to careful thinking, discussion and production of materials. The staff involved have to work as a team. With careful organisation and planning there should be no problems in producing a smooth-running highly satisfying method of teaching.

Strategy

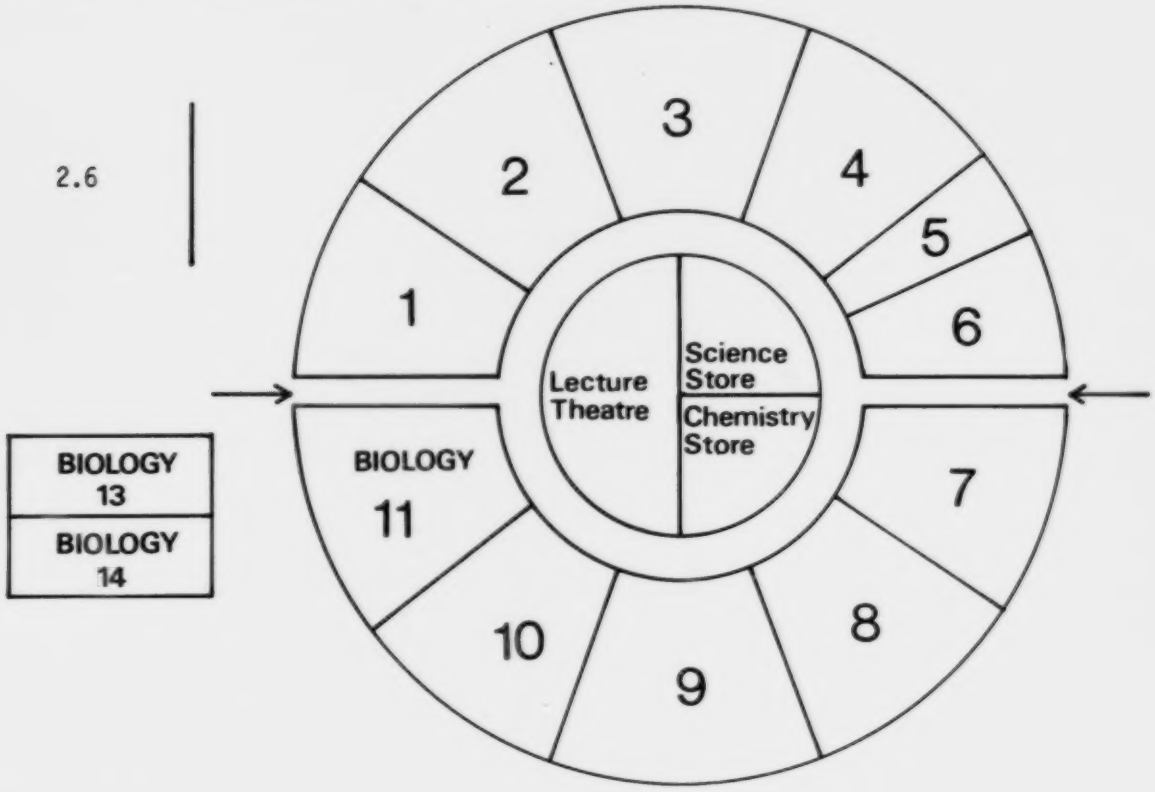
2.5

The course is self-paced within each unit with all pupils finishing the unit on the same target date.

Organisation

The course is taught by the three biology teachers in three 'traditional' laboratories, two of which are in huts just outside the science block (Fig. 1). The lecture theatre is used for large group activities such as lecture-demonstrations, films discussions etc.

Fig. 1 Plan of St. Augustine's Science Block



2.6

The laboratories are serviced with the assistance of a technician who spends, on average, about four hours per week on organisation of the course.

All the typing of course materials is done by the teachers, who also undertake worksheet duplication with occasional assistance from a technician. A duplicator is based in the science store.

2.9 Timetabling requirements were agreed with the school administration and four-period blocks were arranged to facilitate the incorporation of field studies activities.

Course Materials

The course is made up of 18 main units plus 9 Field Studies units.

The Field Studies units contain all the parts of the '0' Grade syllabus which could loosely be termed 'field studies'. The pupils have a separate Field Studies notebook for these units.

Unit 5 - Field Studies consists of four separate field study outings: -

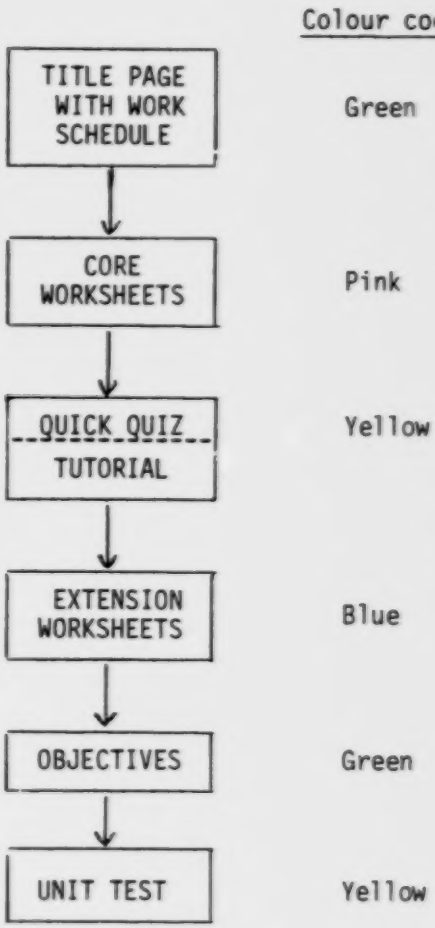
½ day - woodland
moorland
canal

3.1 1 day - seashore in summer

The course model is shown in Fig. 2. It was chosen to cater for all ability ranges entering biology. The core could be considered the basic work necessary for '0' Grade and most of the work necessary for CSE. It is hoped that this model will fit neatly into the new Credit and General Syllabus when it is introduced.

Course Model

Fig. 2



3.3

Each core worksheet usually has 3 - 4 learning activities. These sheets are re-usable and the pupils make their notes on loose leaf A4 punched paper which they store in a ring binder. Occasionally, where appropriate, handouts for the pupils to fill in and keep are used. These are on white paper.

Originally the extensions were of a linear nature. These could be CSE type, extra '0' grade material, Higher material and general interest. Recently we have revised this format and are now producing hierarchical extensions. Ecah core sheet has 3 extension sheets

a) either remedial or extension of core at CSE level

b) extension of the core at '0' grade level

c) more advanced or general interest.

To assist pupils revise for the test, they are supplied with a list of the unit objectives together with a list of the new words encountered in the unit.

The unit test comprises: -

3.3

a core part	- 10 objective questions	(1 mark each)
	- structured questions	(10 marks total)
an extension part	- a balance of questions from the 3 different types of extension	(15 marks total)

3.11 Test results are recorded on a pupil report card. The comment at the bottom of the report card has blanks for key phrases describing the pupil's performance in the core and in the extensions. On the back of the report card there is an explanation of what is meant by core and extension (Fig 3). The key phrases used are described in Fig. 4.

Fig. 3 Pupil report card

FRONT

NAME		SUBJECT	FORM	DATE
Unit	Core Score	Extension Score	Unit Credit	

Comment: This pupil has _____ in the core and has _____ in the extension material.

_____ teacher

3.11

This is completed in triplicate for: Parents; House staff; Science department records. The 3 sheets are colour-coded.

BACK

Explanation of terms used

Core: This contains the important ideas we expect most pupils to master. It includes basic 'O' grade work which could result in a 'C' pass if mastered.

Extension: This is a development beyond the core and includes the more detailed and difficult areas of 'O' grade.

Unit Credit: This is a general award for the pupil's effort during a unit of work and is rated 1 (low) ⟶ 5 (high).

Fig. 4 Advice to teachers on completion of pupil report card (Fig. 3)

3rd Year Biology Reports

The class teacher is expected to fill in the core mark (out of 20), extension mark and unit credit for each unit included in the report. In addition a standard comment has to be inserted in the appropriate place. There is also space for any additional comment the teacher may wish to make about the pupil's behaviour etc.

Comment It is simply a case of putting in the key phrase.

This pupil has CORE PHRASE in the core
and has EXTENSION PHRASE in the extension material

Core phrases	mark
had little success	<11
had partial success	11 - 12
had moderate success	13 - 14
been successful	17 - 18
been very successful	19 - 20

The appropriate core phrase is chosen on balance over the number of sections being reported.

Extension phrases	unit 1	unit 2 onwards
had partial success	1 - 3	1 - 7
had reasonable success	4 - 6	8 - 12
achieved mastery	7 - 8	13 - 15

There may be difficulties in choosing the appropriate phrase as there may be some anomalies between different sections for any particular pupil. It will be a question of using your common sense and balancing the differences, you will also be able to comment on this and the marks on the report will make this obvious to the parent.

Laboratory Organisation

No special apparatus is required other than any board games, card games etc which are devised. Occasionally we also produce our own posters. The units are organised in such a way that seasonal variation in biological materials fits in with the order. We find that equipment very rarely becomes muddled or disappears provided that the pupils are well trained and are aware that

3.14 teachers will check the apparatus. Teacher awareness leads to pupil awareness.

The organisation is not complex and is relatively easy to manage.

3.14 Each member of staff is responsible for the organisation and preparation of a number of units. Just before the start of the unit they check the worksheets to see if any have to be duplicated.

3.12 If so, they collect the masters from a central filing cabinet and either duplicate them themselves or ask a technician if one is available. They are then responsible for making up the class sets of sheets and delivering them to each teacher. The apparatus

3.13 is put together by a technician who has a copy of the apparatus list. All non-consumable apparatus is stored in a box in the biology store. There are usually 3 sets of everything which the

3.10 technician divides into 3 separate boxes for each of the 3 biology teachers. The technician also has a note of any consumables that have to be made up or bought. The apparatus boxes are then delivered to each lab and,at the end of the unit, the technician collects in the apparatus boxes and returns all the non-consumable appparatus to the store in the labelled unit box.

Within the lab. the teacher usually has one area set out for sheets and apparatus boxes. Each sheet is labelled with the unit number as are the apparatus boxes. The apparatus does not

3.10 include extensive amounts of each chemical or item used. We have found that usually one of each is sufficient. Sometimes we may produce two of any one item e.g. games, jigsaws, card games. The spread of pupils over the core and different extensions normally means that there are no more than about two groups using any piece of apparatus at one time. Obviously there are times when each group has to be supplied with one of a particular item e.g. agar plates, crucibles.

Costs

The most significant cost lies in the duplication of materials. This, of course, varies with the method of duplication available in the school, off-set litho being the cheapest and photocopying the most expensive. If the material is to be of a high standard visually these two methods are really the only suitable ones.

Implementation

4.1 Having followed an RBL course in Integrated Science in their first 2 years the pupils require little explanation of how to work other than an explanation of symbols used, colour coding and organisation of work. The first Unit of work aims to familiarise the pupils with the course model. (Fig. 2, p 22)

The pupils all start the unit at the same time collecting the title page from the sheet storage box and also the core sheets. The pupils then work through the core sheets at their own pace. When the pupil has completed a core worksheet he usually has his work corrected by the teacher. The teacher credits the pupil on a scale 1 - 5 (1-lowest, 5-highest) for the standard, quality and presentation of that piece of work. This is used solely as a motivating factor and it gives the teacher a chance to check and correct the work of the pupil before he proceeds any further. All that is required is a quick scan of the work produced looking for key words and phrases.

Once the pupils have completed the core they then sit a Quick Quiz done in the classroom and corrected by the teacher or by themselves from a master folder. At this stage the teacher, with knowledge of their performance in the core and Quick Quiz, directs them to an appropriate extension.

4.2 While the pupils are working through the extensions they are given a target date for the completion of the tutorial and the unit. (This is decided by the department after discussion of the progress of the classes). Just prior to the target date the pupils are given a copy of the unit objectives as a revision guide. This also includes a list of new words encountered in the unit. At the end of the unit the pupils all sit the unit test at the same time.

4.3 Pupils are encouraged to attempt the whole test even although they may not have completed all the extensions available. The test is reported as a core score and an extension score. After the test the teacher collects in all the work for the unit, gives it a final check and gives the pupil a credit for the work produced during the whole unit. All this is recorded on a pupil record card when appropriate for parents' evenings. (Fig. 3 p 24)

The pupils normally work in groups of 2 or 3, these are constantly changing and eventually settle down to groups of similar abilities with a little help from the teacher! Occasionally lecture demonstrations by the teacher are held to deal with some of the more difficult experiments and theory. This helps to vary the activities within a unit.

4.1 We have found that our new format is extremely successful; it has improved pupil interest and motivation. It has also improved teacher motivation. The pupils very rarely complain of boredom for they are engaged in a variety of activities. They seldom sit for a long periods of time writing notes; most of their time is occupied in practical work or activity of some kind even if it is just manipulating cards in a sequencing exercise. The contribution to the success of the course by the actual course materials cannot be over-emphasised. It is extremely important that these should be visually attractive, well laid-out and of a reasonable reading age.

The varied needs of the mixed ability group have been met by the core and extensions model. Previously all pupils were expected to cover the same work, work which was usually set at a standard for A and B 'O' Grade pupils.

Now the less able can operate at a level which suits their ability while the more able can proceed at a rate such that some basic Higher material may be covered in addition to that required for 'O' Grade.

Development of language skills

During the production of the units we have always been aware of the importance of developing the pupils' language skills. We have tried to achieve this by varying the type of activity through the use of extended writing, creative writing with guidance, reading from text books, magazines, posters and handouts. We also try to encourage the pupils to talk and discuss and listen. We refuse to spoon feed; the pupils must be more responsible for achieving the learning outcomes. We take careful account of the readability of the materials and we have used the remedial department in the school to check these materials.

Plans for future development of the course

4.2 Although we are still producing units (there are four more still to complete), our newest units differ in style from our original ones. This change has taken place as the inadequacies of the previous formats became evident. The present format is likely to be very close to the final format for General and Credit Biology and, once we know the syllabus for General/Credit, we hope to adapt what we have so that all the units are in a similar format. Additionally, we would like to develop our assessment procedure with a view to producing a more criterion-referenced quick quiz and end-of-unit test.

S3/4 Physics at Wester Hailes Education Centre

The RBL Physics Course has been developed by 3 teachers in the Physics Department, with support from the Print Room and Laboratory Staff. It began in 1982 as a wide ability range O/CSE course.

Reasons for introduction of the course

1.1 The decision to develop this Course arose from the realisation that the ability range of students opting to study Physics was very wide. The materials which had been used prior to this were failing to satisfy the needs of a large number of students - at both ends of the spectrum. They used far too much paper and relied too much on students filling in gaps. The end-product was not a useful set of documents from which the students could revise

1.2 for short-term tests or the terminal examination. The scheme also had equipment and assessment flaws which were unacceptable to staff and students.

The problem was seen to be that pupils learn at different rates and they have different interests. They begin the Physics Course with widely differing starting characteristics - they have not all learnt the same things to the same depth and so they cannot all be expected to cope with precisely the same work at any time during the course. They must then reach different "best performances" by the end of the time allocated to the Course. Now this happens no matter how the Course is organised but many courses are completed with different levels of failure instead of

1.3 different levels of achievement and result in a teacher-pupil-material struggle all the way through. The staff attitude was

1.4 one of extreme concern that students should be provided with appropriate learning experiences from which could emerge success, confidence, interest and a desire to make progress.

Planning time

2.4 The course materials were produced in school starting from materials already in the existing course. Having planned the implementation over 3 or 4 Departmental meetings the agreed initial time commitment turned out to be very demanding; even after the first course materials were produced there was a great deal of "homework". An average Unit takes about 10 hours, excluding researching, thinking, inspiration-seeking, resources organisation,..... 20 hours overall might be more accurate.

2.2 It is estimated that at least six months are required prior to the introduction of the course to allow for the production of enough material with which to make a start.

Strategy

2.5 The Course is designed to allow self-pacing of the students over the whole Course. Formative and summative assessment take place at points in the Course when the individual student is ready for it.

Organisation

2.6

2.10

The course is taught in a double laboratory (40 pupils), requiring little lab staff support during lessons. Apparatus was prepared by 1 lab technician and 1 lab assistant. All the printed materials were typed by the teachers on electric golfball typewriters. Reprographic requests were controlled by the school office and dealt with by the Print Room operator.

Course Materials

The 4 topics of the Course are Waves, Mechanics, Heat & Electricity.

The Units in each Topic have been grouped into different levels of difficulty and complexity. There are 4 different levels of work. Most-able students may study a Topic in depth, moving through the 4 levels before changing Topic. The majority of students, however, are advised to complete the 'Level 1' work before progressing to 'Level 11' material, and so on. The topics have been coded as per SEB syllabus; I, J, K & L representing Waves, Mechanics, Heat & Electricity. At Level 1 there are 2 or 3 Units per Topic, so that most students are able to work comfortably without the worry of being 'left behind'.

3.1

At any time within the lab there are students working on Units in all 4 Topics. We believe that the sacrifice of "continuity" within a Topic, in favour of "variety" results in greater motivation and better mastery of smaller sections of work. It would not make sense for all these students to, for example, do "all the Mechanics" because of the rate at which new and more complex concepts would be introduced.

The organisation of the Units within levels and the Unit names are given on pp 35-36.

On completion of the Units in a Level of a Topic the student has a Project to complete. The Project provides information on the applications and relevance of the Topic to everyday life. Projects are mainly read/discuss/write type projects, but the intention is to provide some open-ended practical investigations too.

3.3

The practical work, which has to cater for the whole range deals only with "Physics" and avoids the applications unless the connection is very obvious.

Within every Unit the student is provided with a set of learning objectives which are linked to the Activities and also the Unit Test. This Test provides feedback to the student about how much of the work he/she has mastered. The Test is done in the Unit Booklet and is dealt with 'informally'. It is a 2-level test for which CSE and SEB scores are recorded. Objectives not achieved are identified on the Objectives list and the student finds from the Activities list which activities should have contributed to the achievement of that objective.

The study guides given to each student comprise: -

- a Course Handbook which details the content, structure and routines of the Course (see pp 33-37)

- Unit Booklets consisting of 2 or 3 pre-printed sheets and about 5 lined A4 sheets, edgebound to form a workbook.

3.3 The structure within the UNIT BOOKLET is as follows:

Introduction to Topic

Objectives list (pupil)

Suggested timing and student time target

Results of Assessment and details of next Unit

What to do (explanation of Activity procedure)

Activities list (details of text, experiment, problems etc.)

After you finish (feedback by students).

There are two levels of work provided within a Unit and they correspond roughly to General & Credit (CSE & 'O' Grade). In order to cope with the wide range of students there is opportunity for a greater rate of mastery of the higher level work for the brightest students.

3.11 Each student is given a Record of Progress Card at the start of the Course.

Laboratory Organisation

The Physics Department comprises one double laboratory, containing 20 tables and 40 stools, 6 gas/electricity plinths, a few cupboards and drawers, and some noticeboards.
NO apparatus is stored in the lab. All equipment is collected from the central Science store. The lab is divided up into 4 main Topic areas. Nearby noticeboards, workcard trays and
3.10 reference materials match these Topics.

Apparatus is supplied to the lab on 4 trolleys, each trolley providing the basic equipment for each Topic. Each trolley caters for 5 pairs of pupils and so quantities of each piece of equipment are small. The Course could also work just as well in a single lab.

Implementation

The Course in Action

When the third year students arrive the first step is to try to determine the long-term recall and understanding of the work of the S1/S2 Science Course. All students are given a set of 4 PRE-
4.1 TESTS (on Units 7,9,11 & 13 of the integrated science course). Students quickly see how much they have learnt and in which areas of the course their strengths lie. This information, along with individual student preference enables them to decide which Topic of the Physics Course would be the best starting point.

The students are then provided with the Course Handbook and once the 4 pre-tests are completed, they are given the Record of Progress Card and their first Unit Booklet.

Assessment - formative and summative

As described above (p 30), an 'informal' test is taken at the end of each Unit. Remedial work is undertaken by the student, with help from the teacher when required. A Re-Test is suggested if the score is near to or below the 50% level and the student records the Re-Test score on his/her Record of Progress Card.

4.1 A 'Level Test' is taken when all the Units at a particular level have been successfully completed. This Test is dealt with 'formally' and it contributes to Reporting and also CSE. The Unit Test papers are retained by the students but the Level Test papers are all retained by the Department. A student can gain an overall view of progress from the Record of Progress Card which is kept in his/her ring binder along with Unit Booklets. It becomes much easier, late in Fourth Year, to discuss the appropriate level of Certification which the student should be presented for.

Involvement of parents

4.3 Parents' attitudes to the Course are favourable. They are made aware of what is expected of their child by being asked to read and sign the Course Booklet and they follow his/her progress through the Course as their signature is required in Unit Booklets after each Unit Test.

4.1 In this course we have dealt effectively with the usual criticisms relating to pupils using RBL: there is less boredom, the more able are stretched, the less able are not confused and disorientated because they are given realistic tasks.

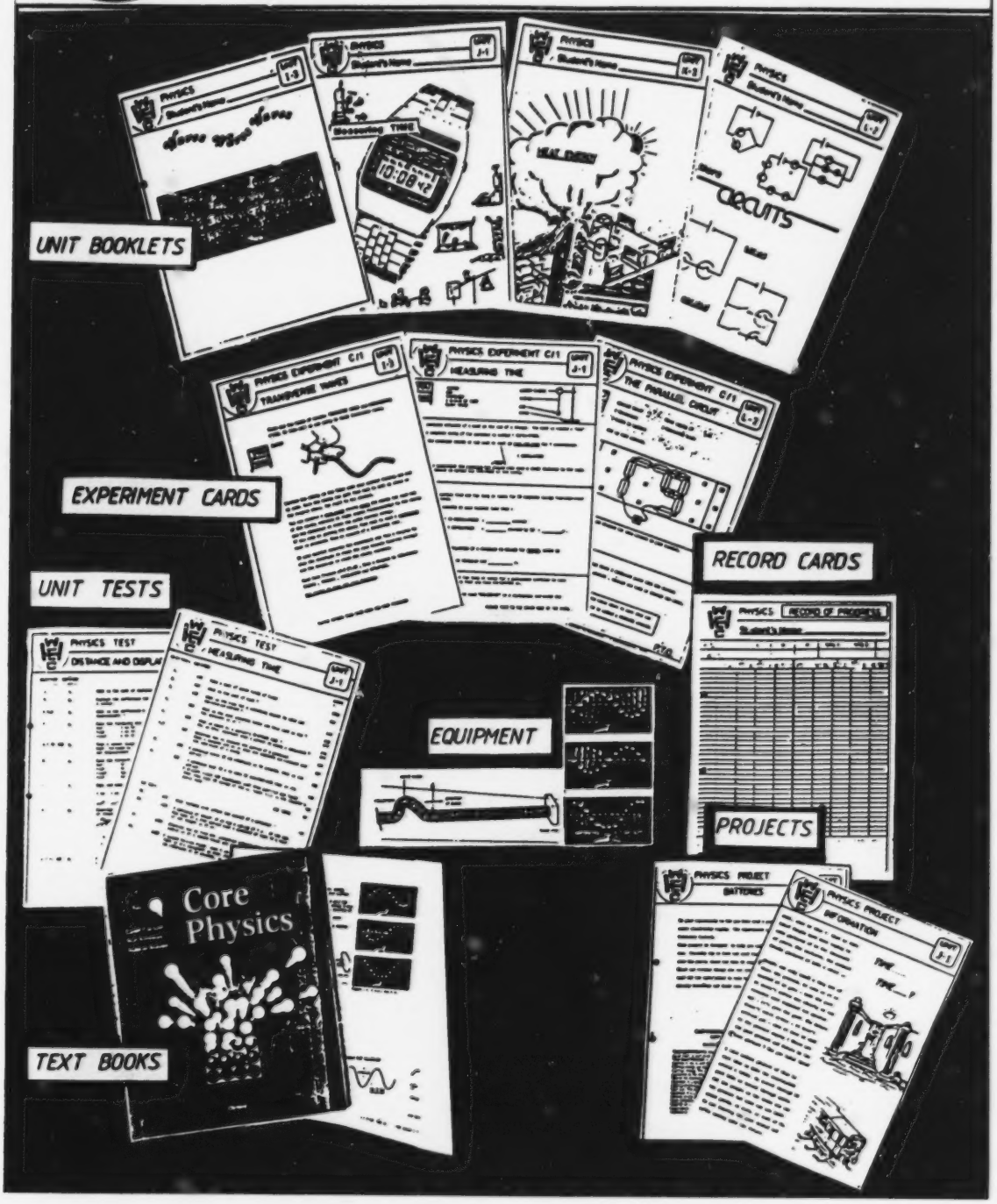
4.2 The Teacher exhaustion relating to production of materials will always exist but the coping during class time has been improved in a realistic fashion.

The organisation of apparatus and hardware has been improved and the running costs have been drastically reduced. Future development of this Course will involve the introduction of more and better Project materials as well as audio-visual and computer components.

The range of this Course will be extended quite easily to cope with the Credit level hi-flyers.

PHYSICS HANDBOOK

Student's Name _____



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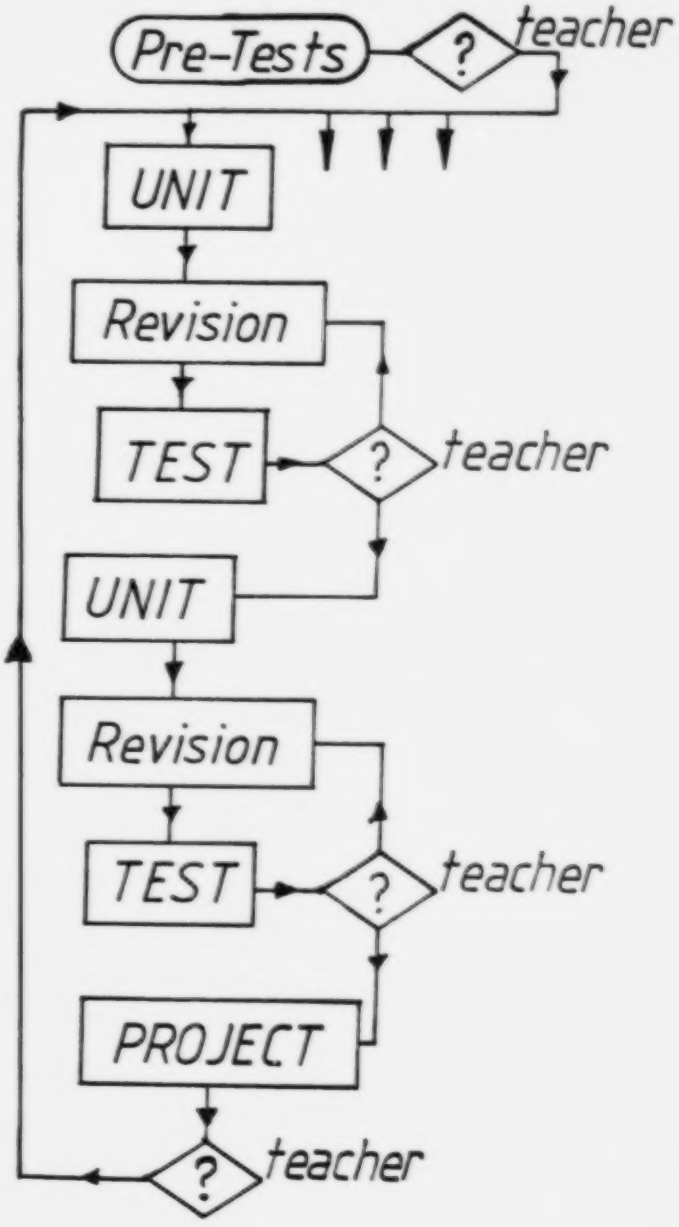
PHYSICS

What You Do



O.K.?

To help you find UNITS they are colour coded and have a letter, I, J, K & L to tell you which Topic they are part of.

The coding for the units is as follows:

"I" "Waves" BLUE

"J" "Mechanics" YELLOW

"K" "Heat" PINK

"L" "Electricity" GREEN

You are NOT expected to study one Topic forever!
The course itself has 4 different LEVELS, starting from Level 1 which is pretty simple but an important starting point, through Level 11, Level 111 to Level 1V where you start exam revision. The UNITS are organised into LEVELS like this:

TOPIC	WAVES	MECHANICS	HEAT	ELECTRICITY
LEVEL 1	I-1-3 Project Test	J-1, J-2 Project Test	K-1, K-2 Project Test	L-1, L-2, L-3 Project Test
LEVEL 11	I-4, I-5 Project Test	J-3, J-4 Project Test	K-3, K-4 Project Test	L-4, L-5, L-6 Project Test
LEVEL 111	I-6* Project Test	J-5,6,7 Project Test	K-5, K-6 Project Test	L-7, L-8 Project Test
LEVEL 1V	R* Test	J-8-11 Project Test	R* Test	L-9-11 Project Test

Notes R refers to Revision units

* refers to non-practical units

There are FOUR main topics in the Physics Course. They are:

WAVES	MECHANICS	HEAT	ELECTRICITY

When you begin the Course you will want to be SUCCESSFUL right from the start.

You are most likely to be successful if you study a Topic that you are good at or that you like.

We begin by giving you a set of 4 PRE-TESTS to help to find out what topics you already know something about from 1st and 2nd year.

When you get your 4 scores write them at the top of your RECORD OF PROGRESS CARD. You can then decide which Topic would be the best starting point for YOU .....your Teacher will then discuss your choice and give you a UNIT BOOKLET.

Here is a list of ALL the unit booklets you will use:

I units	I-1	Reflection of light
	I-2	Refraction
	I-3	Waves
	I-4	Electromagnetic Waves
	I-5	Sound
	I-6	Wave calculations
J units	J-1	Measuring time
	J-2	Measuring distance and displacement
	J-3	Studying movement
	J-4	Speed and velocity
	J-5	Acceleration
	J-6	Acceleration and force
	J-7	Acceleration and mass
	J-8	Gravity and projectiles
	J-9	Momentum
	J-10	Energy and work
	J-11	Machines, power, efficiency
K units	K-1	Measuring temperature
	K-2	Heat energy
	K-3	Boiling and melting
	K-4	Gases
	K-5	Heat equations and calculations
	K-6	Gas equations and models
L units	L-1	Circuits
	L-2	More circuits
	L-3	Potential difference
	L-4	Resistance
	L-5	Resistor networks
	L-6	Electrical energy, power and homes
	L-7	Magnetism and electricity
	L-8	Electromagnetic induction
	L-9	Electrostatics
	L-10	Electronics
	L-11	More electronics

In a UNIT BOOKLET you will find the following headings:

Introduction to topic

Objectives

Suggested timing

Assessment details

Details of next unit to be attempted

What to do

Activities

After you finish

ACTIVITIES WITHIN UNITS

There are three main types of activity: reading, solving problems and carrying out practical work.
Two texts are provided for use in the lab: Core Physics and Physics for You.
Instructions for practical work are provided on EXPERIMENT CARDS.
Apparatus is provided on trolleys in the lab.
Pupils write up experimental work in their unit booklets.
Unit tests are also done in unit booklets.

UNIT TESTS colours as for unit booklets

EXPERIMENT CARDS colours as above

LEVEL TESTS white paper

PROJECT BOOKLETS white paper.

CERTIFICATES

The CERTIFICATE you get at the end of the Course depends on what you achieve during the Course.

We DO NOT decide which qualifications you should be trying for until near the end of the Course. This will be decided by the success you have had throughout the Course and gives you the chance to get the highest possible grading that's possible when you are trying your hardest! You will be presented for the Exam or Certificate which matches your achievements. This will be discussed carefully later.

A Change in Teaching Method

Thoughts about Change

The department's involvement with RBL developed after one staff member had attended an in-service meeting at Dean Centre and returned with considerable enthusiasm for such developments.

1.2 The initial advantages perceived were that an increase in pupil-teacher contact would result in each pupil receiving a course more relevant to their individual needs and learning rates. This would lead we hoped to less pupil disillusionment on finding some work too difficult or rapid.

1.3 My own attitude as Principal Teacher was sympathetic as, if successful, I could see the adoption of RBL as one method of alleviating what I saw as the major problem in the department, a very high drop-out rate in S4 (20-40%).

1.4 One other staff member had fairly neutral views and two other staff members entered as newly qualified probationers and seemed to have no fixed initial attitudes.

Our main areas of concern before starting the course related to whether the most able pupils would be stretched and whether SCE results might suffer and also whether teachers could cope with the increased quantity of marking and recording which the course seemed to involve.

Available Learning Materials

The RBL model adopted was taken directly from the Choice Chemistry Project (see SCDS Dundee, Journal No 21, pp 13-24)

2.4 The materials were to be provided by the Region as part of the pilot work on Choice Chemistry and these appeared to satisfy one of our major aims which was to improve the pupils' language skills by aural interaction with all pupils on a one to one basis and by encouragement to produce their own notes to as high a standard as possible.

The consumable worksheet approach would not be used, nor the "copy and complete" type of workcard, as these tend to restrict the pupils' written responses. This is especially important in core work where the variations in ability require a more open approach to writing.

Thus the pupils learn through doing and not through filling in blanks. Even atomic theory, formulae, and equations have learning activities. Afterwards, the pupils are asked to write about what they have learned. There are no dictated notes from the teacher.

Choice Chemistry is a multi-level course in chemistry which sets out to cope with all but the bottom 20 to 25 percent of the the ability range in Scottish 3rd and 4th year.

The course uses a resource-based learning approach. It informs the pupils of the learning objectives and it employs criterion referenced assessment. It uses a variety of types of learning activity so as to engage the interests of the pupils. All pupils are permitted to work at their own rates within each unit. There is also an attempt to build into the fabric of the course different perspectives of relevance, such as: industrial connections, social implications, domestic applications, and historical interest.

2.5

The core of the course is pitched below 'O' grade standard, but through extensions and further topics it provides the necessary ingredients for those who wish to sit 'O' grade chemistry.

Choice Chemistry is currently registered for CSE mode 3 with NREB in Newcastle.

The scheme is not intended as an individualised system in which pupils work quite separately from each other. Pupils are normally expected to work in groups of two. They are expected to discuss with their partners and with other groups as they work. Talking in the lab. is not only permitted but highly desirable and the teacher's role is to encourage it.

Talking is also formally structured into the courses through the use of interactive activities. VCR tapes lend themselves to group discussion after showing. When pupils write up their reports they are again encouraged to discuss what they will say with their partners. Another opportunity for constructive talk is when a pupil who has been absent returns. The other pupils enjoy being able to explain what they have learned.

There are many different kinds of learning activity. Carrying out experiments is just one. The writers have set out to build in a variety of types of activity, such as: reading books, looking at pamphlets,studying posters, watching films, discussing with each other, visiting industries, writing about experiences playing educative games (such as Compound Dominoes), making models, drawing diagrams, examining displays, answering questions, etc. None of these were new and none were gimmicky. Continual variety was the key.

Pre-Planning

2.6 The Chemistry Department was provided with one traditional laboratory with fixed furniture and limited circulation space. There were also two 'temporary' laboratory units separate from the main school building. These were provided with side services and loose science tables. Problems already existed regarding the distribution of equipment and materials and the storage facilities were seen as being inadequate.

We were aware before starting RBL that we would have problems both with apparatus and worksheet organisation and that this would be amplified by the department's geographical layout and lack of adequate technician support,

3.14 The major problem with apparatus and materials seemed to arise through the requirement for small purpose-built pieces of apparatus for specific experiments such as conduction testers and here the lack of a science technician with adequate workshop facilities would be a serious handicap.

We anticipated that costs of running RBL would be greater than traditional teaching methods, particularly in consumable paper. Indeed the development of RBL in S3/S4 at North Berwick High School would have been in some doubt without the initial input of some support as a pump-priming exercise. Apparatus requirements are different but are not significantly more expensive and the use of per capita planned over a four year period can produce the required changes by planned replacement of consumable materials.

The consumption of chemicals is likely to be greater but this is mainly with relatively cheap chemicals such as hydrochloric acid and sodium hydroxide. Recently we have found the increased consumption of metal elements a minor problem.

The trial phase of this Project called for a major in-service programme. The small expansion during the pilot phase had clearly signalled the need for this. So different from traditional practice was the learning approach for the pupils, the new role of the teacher, and the laboratory organistaion of resources that an on-going in-service training programme was found to be essential.

The following pattern of meeting topics was developed.

A. BEFORE COMMENCING

3.10-3.14
1. General Philosophy and Practice
2. Organisational Planning
3. Staff visits to exemplar schools
4. Operating a Multi-level System
5. Introducing the Pupils
6. The Teacher in action

B. AFTER COMMENCING

1. Unit 1. Development of formulae/equations. Pupil note-making
2. Unit 2. Development of organic chemistry. Assessment/ reporting
3. Unit 3. Development of atomic structure. Using micro-modules
4. Unit 4. Cnemical calculations. Review of management/ practice
5. Unit 5. Further look at equations. Industrial visits
6. Unit 6. Organic chemistry continued. Micro-computing
7. Unit 7. Redox theory. Revision work and prelim exams
8. Unit 8. Review of chemical theory. Final evaluation.

2.7 The training meetings were held at six-week intervals, each meeting taking two hours.

2.6 Safety aspects of each unit are thought out before the start of each Unit and this is continually updated should any member of staff observe any unsafe situations arising from pupils use or misuse of materials. In this respect there are particular advantages in being able to organise that pupils can carry out practical work and written work in different areas either within a room or in separate rooms.

Implementation

Pupils are introduced to RBL in S2 though no fixed format has been given to this introduction. We are intending to look at this in an attempt to improve induction before next year.

4.1

S3 work is begun 2 periods per week at the beginning of May in S2 to allow the '0' grade course to be covered in 4 periods per week.

The pupils initial attitudes in S3 have been extremely positive although this did deteriorate somewhat in S4 as they become more aware of the pending '0' grade exam. The classwork associated with Choice Chemistry does not appear to them to bear much resemblance to the work required in order to respond to the questions in past papers. I find in fact, after '0' grade, most of the RBL pupils report no more difficulties with the '0' grade than those taught traditionally. Up to now no formal links have been made with any other departments in S3/4 though remedial support was given in S2 in session 82/83 by the timetabling of a remedial teacher to chemistry. This year, due to a change in the options available to pupils in S3, a few pupils of particularly low ability are following a course in Chemistry. One at least has severe writing difficulties. When our teacher of remedial education returns in January some additional support will become available. Our experience over the last year has been of the less able attempting work which is too difficult due to the general competitive atmosphere within the school.

Advantages which have become apparent later are the use of mastery type diagnostic tests and unit tests leading to lower pupil drop-out rates as they perhaps perceive themselves achieving short term success. In addition more individual pupil/teacher contact has led to pupil/teacher relationships being improved in some respects.

4.2
4.4
2.7/2.9

Initially the staff found the RBL methods harder work than the teaching methods used previously but were coping and becoming more efficient as they became more experienced with the work. Since August, all prep time, including that of promoted staff has been cut to the minimum of 200 minutes and this has had a serious effect on RBL developments within the department. Pupils are tending to be held back due to larger time lags between collection and marking of work and a reduction of 'quality' in the one-to-one contact between pupil and teacher.

However once familiar with the course all staff appear keen to continue with RBL but some misgivings about lack of preparation and marking time and technical support cannot be ignored.

Storage, distribution and maintenance of software and hardware continue to pose problems due to the geographical layout of the department, the lack of a full time qualified science technician and an inadequate technician preparation area.

4.2

Last year many difficulties were due partly to us still finding our way through the course. We had hoped that this year most of our problems would have been alleviated as we became more familiar with the learning materials. For a variety of reasons this has not been the case and major organisational issues still remain to be tackled.

Preparation and initial distribution of hardware is normally carried out by the technician while the maintenance of equipment kits and worksheets is the responsibility of the teaching staff. Lack of prep time and particularly high room usage does create difficulties in terms of ensuring that the correct resources are available at the correct time. There may well be a need to adapt the present learning materials and patterns of organisation to take account of such limitations in support and provision.

The attitude of the school technicians to the course has been fairly neutral and it is hoped that they can be more directly involved in finding ways of alleviating inevitable problems as they arise.

4.3

Parents of pupils have not been informed directly of our change in teaching approach but the nature of the course (i.e. CSE or 'O' grade) and the homework required, e.g. writing up of final draft notes is communicated via report cards and year handbooks. We have had little parental feedback apart from a handful of parents concerned that their children might have less chance of success at 'O' grade through our use of RBL. Most of these pupils have in fact done very well at 'O' grade.

Future Plans

As a learning method RBL is considered both by the majority of pupils and the teachers in the department to offer many rewards. In Scotland the Dunning Proposals will introduce General and Credit Chemistry covering 70% of the ability range. We have found that the multi-level structure of Choice Chemistry permits the use of such materials at any particular level or with mixed groups. Indeed with mixed groups the final decision regarding level of examination need not be taken until near the end of the course.

With our present more limited resources we are having to consider the possibility of a less ambitious system of RBL which can still be expected to produce many of the advantages associated with more sophisticated patterns of organisation.

Departmental thinking with respect to S1/S2 prior to adoption of RBL.

1.1 The three science subjects have used resource-based learning techniques to teach 'O' grade classes for many years now and consequently there was much interest in extending the approach to other areas of the science curriculum.

An early departmental paper outlined the main concerns prior to changes in the S1/S2 curriculum by defining several 'broad objectives'; viz

1. Motivating and retaining the enthusiasm of the pupils. There were particular problems with S2 classes.

1.2

2. The development of language and number skills.

3. The development in the pupil of a core of fundamental scientific principles and facts.

4. The development of a criterion referenced assessment scheme.

It was considered important at this time to give all pupils, whatever their ability, the opportunity to carry out all practical work considered crucial to the mastery of basic scientific skills. The paper continued by noting that the course should provide sufficient work to occupy and stretch all members of the class and that such work should be presented in an attractive and varied form. Independent activity was to be encouraged and pupils were to take much of the responsibility for their own learning.

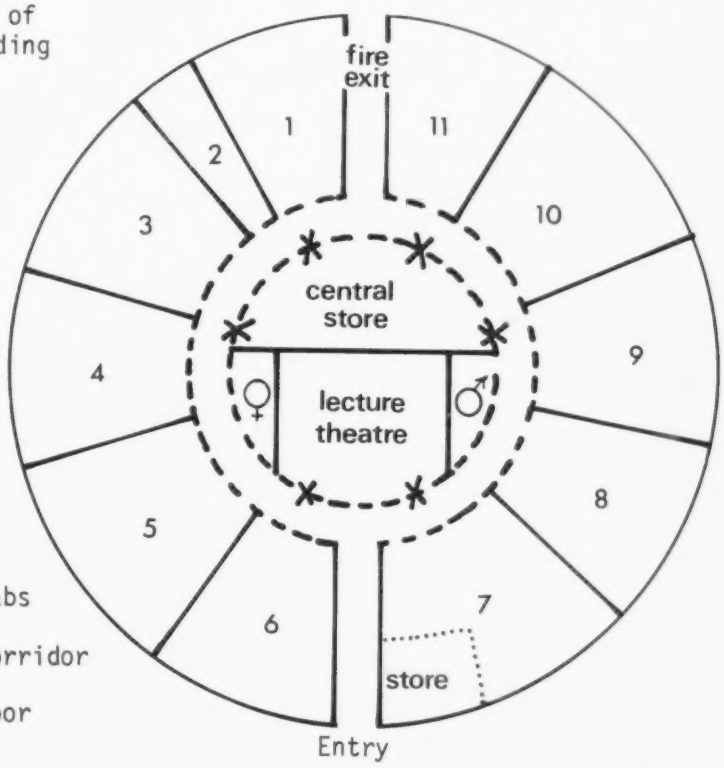
1.3 Staff members originally came to agreement about course changes through a series of structured discussions. This early work was crucial in disarming teacher individualism: there is little point in introducing fundamental change to the curriculum by giving the department a short lecture on the wonders of RBL because it is the classroom teacher who will ultimately give these changes meaning. The extent of the staff's commitment to the innovations was then evident in their willingness to write

1.4 materials for homework. The new course has been welcomed by staff as a 'success', in our own terms, of course, but RBL in the early years of science education has made classroom-life more bearable and more fruitful.

Holy Rood High School is a denominational six-year comprehensive school, situated in the east of Edinburgh. The Science department is housed in a single storey circular building and comprises a central store, 8 large teaching laboratories, 2 small tutorial rooms which have had to serve as classrooms and 1 lecture theatre which accommodates 40 pupils. There is also a small room suitable for sixth-year work.

2.6 The close proximity of the three subject departments - chemistry, biology and physics - has encouraged the science staff to co-operate in course development, and indeed in virtually all other aspects of science education in the school. The building's geography provides some specific advantages too for resource-based learning, particularly when servicing labs from the storage areas, but there is the disadvantage of walls which divide the pupils' working areas; given that large numbers of pupils are timetabled to science together, any course had to be designed to minimise the movement of pupils from room to room. The department has a staff comprising 10 full time teachers, two technicians and two lab assistants. All the teaching staff would be involved in the development of the S1/S2 course. One lab assistant would be solely responsible for its servicing.

Fig. 1 Plan of building



Key

1, 2 etc. = labs

\- - - - - - - = corridor

X = door

2.2 The new units were to be introduced as they were completed and the initial one would confront classes early in 1981. The most recent unit (section 11) was completed in June 1983. The course is best described briefly as a modular, individualised Science course for S1/2 which attempts to teach process skills to the whole ability range, including those pupils with reading and writing difficulties. The course is self-paced within each unit. Whilst much of the material will be familiar to any Scottish Science teacher, a deliberate attempt has been made to simplify the presentation of core topics, particularly the language used in worksheets etc., and much of the content is used as a vehicle for teaching practical and communication skills. The entire S2 course was rewritten by individual volunteers in the department in 1980/82, followed by the S1 course in 1982/83. It is impossible to give an accurate indication of the time commitment which this work involved, given the individual nature of such creativity, but a reasonable estimate would be in the order of 20 hours work per unit. Most of this was of course completed outside school time. All the typing of worksheets masters were to be done at home by the teacher writing the unit.

2.5

2.4

2.6

2.10 Worksheets were to be produced on an offset litho which was originally in the Science department and which was staffed by the three Principal Teachers of Science. The school's reprographic facilities have recently been centralised and are now staffed by office personnel.

2.7 The school management is kept up-to-date with all innovations in the Science curriculum and the school provided some funding for computing facilities to support one particular change. A great deal of constructive criticism has been offered by the headteacher and his management team concerning the more radical aspects of the RBL approach. Time for development work has also been available during the school in-service programme and this has has been a crucial factor in arriving at an agreed departmental 'philosophy', one which was then unlikely to be misinterperted in the classroom. There have however been unavoidable timetabling restrictions: large numbers of S1/S2 pupils are invariably blocked together for Science time and this has resulted in a more formal course structure than is perhaps necessary.

2.9

The Purpose and Production of Materials

3.1 Weekly departmental meetings were conducted in the first term of session 1980/81 to consider changes to the S1/S2 assessment strategy. The discussions were wide-ranging, structured, lengthy and extremely important and informed by the firm commitment of the staff to RBL (engendered by using RBL courses with 'O' grade and CSE classes). The result was an assessment strategy which would NECESSARILY lead to diagnosis and remediation in the mixed ability classroom and which therefore required a more refined course structure. In effect the inclusion of assessment in the teaching design, rather than as a mere appendage to it, required changes in other teaching strategies.

3.9

3.11

Assessment

The department has for some time been attempting to develop a coherent assessment policy which would incorporate the basic tenets of good teaching practice. In our view assessment is most useful as a teaching strategy rather than as an appendage to classroom practice, concerned primarily with education rather than with certification. Thus the S1/S2 course was identified as an ideal forum for describing the range and quality of each individual pupil's achievements as positively as possible without reference to the performance of others. The educational aim has been to aid pupil learning by providing an accurate indication of strengths and weaknesses across a wide range of attributes.

3.11
2.8

Various criteria of performance were identified (in departmental discussions) and these required various methods of assessment, ranging as described earlier from informal daily diagnostic decisions to more infrequent and more formal diagnostic instruments (such as tests and observation checklists). These techniques have now been integrated into a coherent teaching tool, an assessment STRATEGY, which leads purposefully towards further learning by the the pupil.

Fig. 2

TYPES OF OBJECTIVES

	Cognitive	Practical	Classwork	Attitudes
METHOD	a. Checkpoints on worksheet b. Diagnositic quizzes c. Criterion ref. tests (Diagnostic) (Tests are preplanned)	a. Structured observations of practical skills; 5 core skills identified b. Practical items included in tests	Structured observations of pupils behaviour reading writing oral listening group work	Expressed via pupil report (structured) confidence interest homework initiative
REPORTING PROCEDURES	a. Directly to pupil by teacher b.c. SCRIBE computer b.c. Pupils complete own analysis of performance Performance summary under headings in report	Positive comments in 'science report' - 'How you could improve x'	Comments in report which condense the above information Extended written response in science report by teacher and based on observation	Only 'poor' attitudes are related directly to parent through our discipline procedures
ACTION TAKEN	a. Remedial and extension work in each lesson b. Remediation after each test Specific remediation is available at end of unit	These objectives are best remediated continuously through a 'spiral' curricular approach		

3.11 Each type of achievement is then reported to pupils in a positive way, either through a computer-generated report in the case of cognitive objectives, or by way of a structured 'science report' which identified areas of good performance whilst also offering advice on those skills which have not been mastered. These reporting facilties are considered to be primarily formative and thus to serve as a first step towards remediation.

3.11 The SCRIBE computer-generated report is produced after each 'self-help' test and it offers the pupil and parent an insight into some aspects of science attainment.

An example of this report is reproduced in fig. 3 below.

Fig. 3 Unit test report for first year pupil.

HOLY ROOD HIGH — School Ref. 12

12/1.9 — Class Ref. 9

Report on your scores in SORTING THINGS OUT

DAWN — Ref. No. 112

	Your Score
KNOW HOW TO SORT INTO SETS	3 out of 5*
KNOW ABOUT LIVING THINGS	6 out of 6
MEMORY WORK	2 out of 3
OBSERVING ACCURATELY	2 out of 3
KNOW ABOUT VERTEBRATE GROUPS	5 out of 6
USING KEYS	4 out of 6
MAKING KEYS	2 out of 4*
UNDERSTANDING A "TABLE"	2 out of 3
KNOW ABOUT VERTEBRATES	3 out of 4
Your Score on the Whole Test	29 out of 40

Wrongly Answered Questions

KNOW HOW TO SORT INTO SETS	8, 9
KNOW ABOUT LIVING THINGS	All correct, Well done!
MEMORY WORK	14
OBSERVING ACCURATELY	16
KNOW ABOUT VERTEBRATE GROUPS	27
USING KEYS	32, 33
MAKING KEYS	34
UNDERSTANDING A "TABLE"	35
KNOW ABOUT VERTEBRATES	19

*** Note to Pupils ***

Stars show the parts of the test where you have low scores. Ask your teacher what you should do about these. If you have given any wrong anserws, you might like to try to answer correctly now. More work may be necessary first.

This report is given to each individual pupil and it records attainment of a number of reporting objectives. Each reporting objective that is not mastered is highlighted by a*. The'star' system enables the teacher to follow up the test with work that is specific to the pupil's area of difficulty. (N.B. This idea can be used without a computer. See SCDS (Dundee Centre) Journal No 24 p37)

3.11 The pupil also receives a personalised 'science report' several times a year recording his/her attainment in a variety of seminal areas of scientific behaviour (example p 51).

This report has recently been augmented by a computer-generated profile which accumulates results for each pupil on a series of up to 20 tests. The profile contains a series of teacher-defined comments on each skill area.

3.1 The course is modular and individualised and whilst each unit includes much that is reminiscent of Curriculum Paper 7 there is also much that is new. Indeed the content of the earlier S1/S2 course has had to be pruned considerably to give adequate time for remediation work and to enable teachers to concentrate on the development of practical and communication skills. There are

3.3 13 units at present, each designed to fulfil objectives that were

3.7 generated and shredded in departmental workshops. The first unit provides a short orientation for incoming S1 pupils. It includes an easy introduction to course structure, assessment and methods

4.1 of working and therefore lasts a mere three weeks; other units require approximately five or six weeks (20-30 periods of 35 minutes each).

The unit titles are as follows:

STARTING SCIENCE (safety, observation, accuracy of measurement)
SORTING THINGS OUT (Sets, observation of living things, keys)
ENERGY (Types and uses. Project included)
WHAT ARE THINGS MADE OF? (Development of a theory, use of a theory)
CELLS AND SEX (Looking at cells etc., reproduction)
MEASUREMENT (Units, techniques and accuracy)
ELECTRICITY (Electrostatics, current, A & V etc.)
BREATHING (Breathing system, simple gas tests including hydrogen, composition of air)
ACIDS AND ALKALIS (Hydrogen and water, elements and compounds, acids and alkalis)
THE SENSES (Eye, ear, etc.)
THE EARTH (Basic astronomy, structure of earth, some geology)
FOOD GLORIOUS FOOD (diet, teeth, digestion and waste disposal)
FORCES (What they are and what they do)

The typical unit structure is represented in fig. 4 below.

SCIENCE REPORT DATE _____

NAME _____ CLASS _____

1 CLASSWORK

You are good at

Try to improve

READING		BY ANSWERING QUESTIONS	
CORRECT WRITING		BY ASKING QUESTIONS	
DESCRIPTIONS		BY LISTENING	
DIAGRAMS		BY GIVING YOUR OWN IDEAS	
EXPERIMENTS		BY HELPING OTHER PUPILS	
BY DOING HOMEWORK		BY WORKING MORE ON YOUR OWN	

2 PRACTICAL WORK

Following instructions _____

Skill with equipment _____

Accuracy _____

Safety _____

3 TEST PERFORMANCE

With Questions Requiring	Requires attention	Satisfactory
a) recall of facts		
b) understanding		
c) application of classwork to new situations		

58

TEACHER COMMENT

51

Course Recommended for S3

PARENT/GUARDIAN COMMENT

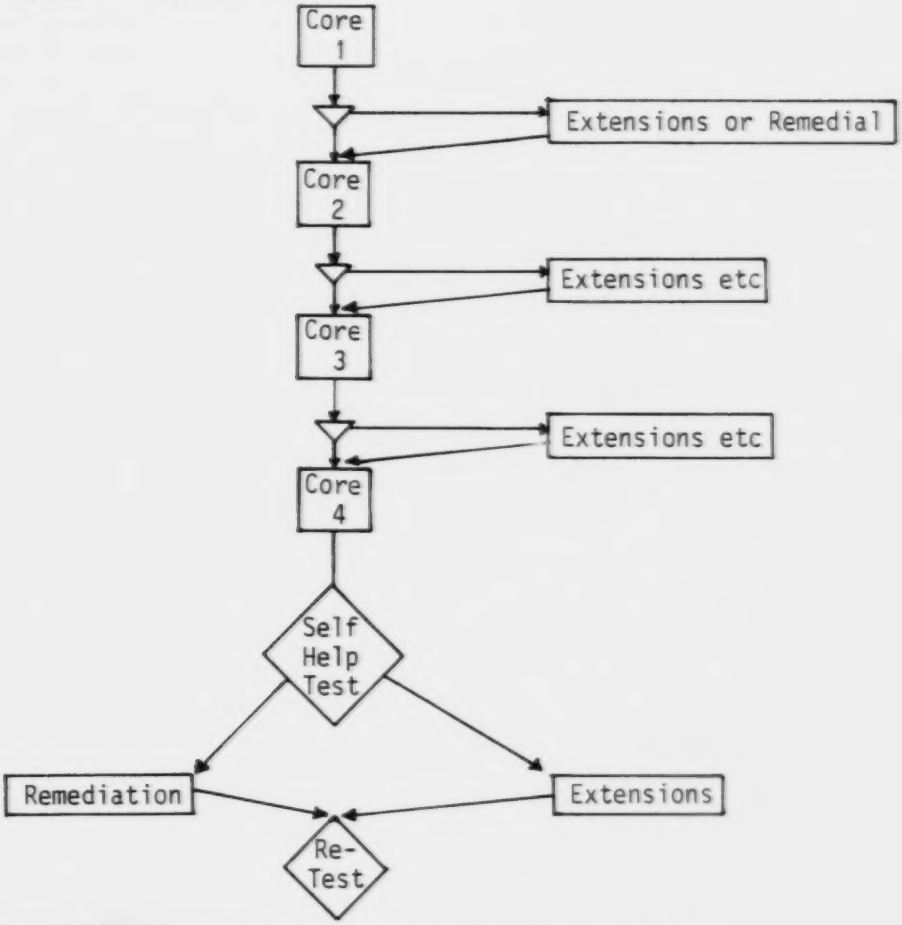
Please add any comment concerning your child's work in science, the format of this report and any other aspect of science education at Holy Rood H.S.

Signature _____

PUPIL COMMENT

59

Fig. 4 Flow diagram of typical unit



key ▽ = checkpoint or quiz

Used as an assessment of the need for remediation. Remedial action is normally teacher centred but directed towards individuals or small groups.

Extensions

Extensions aim to re-inforce the 'core' work and to introduce new ideas and links with other work. These sheets do not include specifically remedial material.

3.3

3.10

3.13

Many different resources are used within each unit to provide a variety of learning opportunities for the pupil. These range from traditional 'teacher demonstrations' to use of video and computer programmes. The most structured and most useful resource (apart from the class teacher) is the colour-coded, non-consumable worksheet, of which there are several different types, viz:

1. a core worksheet containing practical activities and specific writing assignments. Pupils are usually required to write their own experimental reports. (Colour-coded white)

2. an information sheet which presents and discusses theory and facts. Pupils are usually required to read and understand the information and then to answer questions or write summaries of relevant points. (Coded blue)

3. a number of extension experiments or extension 'interpretation' exercises, again on worksheets. (Coded gold)

4. a remedial worksheet to correct misunderstood core work, or an easy-extension worksheet to consolidate the core work. (Also coded gold).

3.11 The teacher is required to assess each core sheet at a 'checkpoint' a device which ensures that the common, good classroom practice of informal assessment and correction is made explicit to teacher and pupil. At this point the teacher will decide if the pupil has mastered the core topic and can then attempt extension work or alternatively if some aspects of core work require remediation.

Each core topic is thus self-contained and this allows the teacher to control the pace of the pupils through the unit, teaching the class as a group if necessary. The structure hence enables the department to cope with large numbers of pupils at the same time and yet still cater for each individual's own work pace. Pupils who work quickly master more, but everyone masters the core, colouring each 'core' box as the checkpoint is passed and recording the results of check-tests and so on. This progress sheet has a vocabulary list for pupils to complete on the other side.

3.11 All core work is finally assessed in a 'self help test', so-called because its function is to correct any difficulties that the pupil is still experiencing with the core material. This test was originally marked and analysed by the pupil and some limited diagnostic decisions were then made by the teacher, based on the PATTERN of wrong answers which the pupil gave. The marking and analysis of the diagnostic test are now completed by an APPLE II microcomputer, using the SCRIBE package. The system enables the class teacher to make a more accurate diagnosis of learning difficulties and allocate remedial work as appropriate. This assessment is quite distinct from the informal lesson-by-lesson checkpoints discussed earlier and its organisation is much more formalised. Similarly, the remediation is also more formal, particularly in its obvious link with the test report which each pupil receives. Pupils have thus come to perceive their test performance as an indicator to further learning activities rather than as a summary comment on their worth.

The retest at the end of the unit simply records the gains that pupils have made during the week of remediation.

Organisation

All promoted staff within the science department (s) consult on spending priorities and materials are bought according to greatest need, whether they be ostensibly for Biology or CSE or whatever.

3.14 Teachers can book the department's video or computer equipment 1 week in advance on a centralised board. Lesson materials are ordered at least one hour in advance on an order chitty.

3.10 The worksheets and equipment for each core topic are then delivered on a trolley to the teacher's room by the laboratory assistant. The worksheets are packed individually in plastic
3.14 folders to reduce wear and tear and there are generally 20 core, 10 information and 5/6 of each extension and remedial sheets required per lesson. All these sheets are of course returned; any cut-outs, homework sheets, models and so on are printed on white consumable paper.

All equipment is stored in plastic trays and it is available, if required, for any other science course once each specific unit is finished. A surprising amount of use can therefore be made of most apparatus. Worksheets, in plastic folders, are stored flat in little blue boxes.

Although the individualised course requires a more varied selection of practical equipment it also requires fewer pieces of each item. Pupils do use a number of materials in one lesson, but conversely not all pupils use the same materials and consequently the bill for chemicals and apparatus is certainly no greater for RBL courses than for others.

There are usually two units operating simultaneously for each year group because of equipment shortages and it is usual to find several different core topics being conducted within the same classroom. However one can find classrooms where all the pupils are always on the same core topic, albeit at different stages within it.

Development of Skills and Processes

1. Cognitive Skills

4.1 Resource-based learning is designed to encourage the pupil to take decisions without recourse to the single right answer from the teacher. This independence stresses the development of process skills like observation, recording observations, identifying problems, drawing conclusions and researching information, whilst reducing the impact of memorising and recalling information,
4.2 given that the teacher no longer spends much of his time passing such facts on.

All the learning materials have been designed with such skills in mind and processes are assessed towards the end of the unit along with the more usual items which test recall and understanding of facts. A profile report is built up over a number of units to indicate the pupil's cognitive development.

This records progress in areas such as

KNOW AND REMEMBER SCIENCE FACTS	UNDERSTANDING IDEAS
REMEMBERING FACTS FOR A LONG TIME	USING NUMBERS
USING GRAPHS AND TABLES	RECORDING OBSERVATIONS
RECOGNISING EXAMPLES OF CONCEPTS	DESCRIBING CONCEPTS
APPLYING CONCEPTS	

2. Language Skills

For some time the Integrated Science course has been taught to classes which are 'true' mixed ability groups, reflecting evidence which suggests that remedial form classes are best integrated with other pupils where possible. Holy Rood was fortunate that these views were translated by the specialist remedial teachers into an effective programme of cooperative teaching. The staff involved have identified the following successes of this 'double
2.9 banking' (as constituted in 1981), successes which applied to ALL pupils.

1. The idea of remediation has been applied to all pupils and hence weaknesses in reading and writing skills have been identified throughout the ability range.

2. The common course materials have been more carefully designed. They use much simpler and clearer language and they reflect the view that all pupils experience some difficulty with scientific language.

3. Individual attention in the specialist areas of reading and writing has been given to pupils more easily.

4. There is a more general awareness and a more active concern amongst science staff with crucial cross-curricular skills (reading, writing and oral work.)"

Many other benefits were also identified, for example the positive social effect and the reduction of stigma for the slow learner. The 'double banking' was certainly a major influence in making correct language use an issue, and an objective, in the S1/S2 Science course.

Thus pupils are now encouraged to write extended reports of practical work, to read written materials of varying degrees of difficulty, to keep vocabulary lists of 'new words' (the most important of which are listed in the vocabulary list) and to take part in oral work. All these aspects of the pupil's performance are assessed at regular intervals and the assessments are reported to pupil and parent in an extended personalised report. (See later sections for details.)

3. Practical Skills

Experimental activities are directed mainly by pupils although there are a few demonstrations which are conducted by the teacher for safety reasons. Pupils work in pairs or individually if they choose to, using the worksheets as a guide to technique: indeed one of the department's assessment criteria is 'following instructions'.

The materials are designed to encourage pupils to work independently, solving problems with practical work on their own or in a
4.1 group. The teacher is generally considered as 'the last resort'. Thus several key words are used on worksheets to indicate changes of activity to the pupil;

READ	Generally used in the introduction of a practical activity to set the scene
LOOK or DRAW	Used to emphasise features of the apparatus
DO	Used to identify the procedures which must be followed during the experiment(s). Each procedure is broken up into a series of short, numbered steps and drawings are often included to help the pupil translate the written instructions
ANSWER	Used to direct the pupil's final written report and to tease out specific teaching points from the practical exercise
COLLECT	Used in earlier units to identify the pieces of apparatus which the pupil requires to complete the experiment.

Pupils can therefore follow the written instructions, leaving
4.2 the teacher free to deal with learning difficulties rather than procedural ones. The teacher is also able to observe the practical skills of each individual, giving help and encouragement where necessary and remediating any short-comings.

The department requires an assessment of each individual's practical skills, drawn from such observations and categorised under four headings:

FOLLOWING INSTRUCTIONS, ACCURACY, SAFETY AND SKILL WITH EQUIPMENT

These skills are also assessed formally in the 'self-help' test when pupils perform practical test items.

4. Other Classwork Skills

The department also hopes to inculate certain attitudes and social skills as these are an important component of any science teacher's objectives. Some attempts to measure indicators of 'desirable' pupil attitudes have been made.

Present Attitudes to the Course Structure

4.1 Pupils. Pupils are notoriously conservative in their attitude to change. However a lengthy study of pupils' perceptions of the new course structure revealed that there was a wide experience of success with both curricular and assessment materials. Presumably the pupil who feels successful will also feel happy. Certainly the original problems of motivating the S2 classes, a factor in changing our course, has largely disappeared.

4.3 Parents. Parental attitudes are often difficult to assess; the majority are a silent majority and it is often only after some educational disaster that one hears parental voices. However the department sought to collect parental comments on the innovations in the S1/S2 science curriculum by giving a right of reply on the pupil's 'Science Report'. Both pupil and parental comments have been collated and analysed, and some early results are presented in fig. 5.

4.4

Parents have also, without exception, been complimentary at parents evenings, when talking of the science course, albeit to members of the science department.

Fig. 5 Comments from early science reports

PUPIL COMMENT N 175		PARENTAL COMMENT N 175	
Category Label	M	Category Label	M
Like the report	40	Like the report	61
Dislike the report	0	Dislike the report	2
Notes specific intention to improve 'X'	38	Notes parental action to improve 'X'	24
Notes liking for experimental work	40	Offers specific suggestions/information	55
Notes other specific likings	52	general comments	34
Notes specific dislikes	20	Mentions attainment grades	0
Notes that X is 'boring'	17	Illegible	1
Offers useful information on performance	12	No parental comment	20
No pupil comment	36		

N.B. 1. The categories are not exclusive

2. The return rate for reports was 79.5%. One report was eaten by family dog

3. Subsequent issues of 'science reports' have had a lower return rate (65%)

Problems?

4.2 The adoption of RBL requires that the teacher change his traditional classroom role, becoming the major resource for his pupils. This role change is difficult, particularly when colleagues in other departments are firmly committed to some other system: an RBL classroom is usually a little noisier than others, there is more activity and pupils get out of seats and walk around without asking for permission. I suspect that this change of role is at the core of many of the arguments about RBL techniques.

3.10 There are of course real problems, real practical problems. The teacher who introduces RBL requires good storage facilities for the different resources that are required and an adequate system of managing a variety of multi-level materials within the one classroom. For a system to become fully developed he needs too

2.6 to be able to count on the services of a competent technician and a pleasant reprographics department. He should be energetic enough to move continually around the classroom and yet relaxed enough to spend 10 minutes with one pupil if necessary. Finally he must have a masochistic trait to enable him to write the materials in time for next term .....

But what's new? These 'problems' should be familiar to all science teachers.

At least RBL has a powerful pay-off in the classroom.

Future Development

4.2 The course has now been almost completely translated into the 'new' format and it is therefore likely that future development time will be allocated exclusively to S3/S4, and eventually to S5/S6. It is probably an indicator of teacher satisfaction that

4.4 no-one has recently seen a need for a new worksheet or a re-written test!

Appendix I

Some HMI Observations on Teaching and Learning in Scottish Secondary Schools

A. SED (1982) Learning and Teaching in Scottish Secondary Schools: The Contribution of Educational Technology HMSO

Para 1.1 The approach widely adopted by Scottish teachers, according to our survey, was whole-class teaching. This confirms the observations of HM Inspectors in other reports recently published and in secondary schools applies particularly to the teaching of 'classroom' subjects. Our observation of teaching methods indicated a high degree of uniformity of method from one teacher to another, and from one school to another. Subject approaches appeared to differ, but they generated similar kinds of learning opportunities and experiences. The features consistently to be found were teacher talk, question and answer, and assignment, in that order. Almost invariably the culmination was a form of assessment, varying from informal checking, orally or in written form, to formal correction of the work done.

Para 1.4 Teachers justified the class-teaching approaches they had adopted on severely practical grounds. Syllabuses were crowded and demanding. In order to cover them, corners had to be cut by concentrating on what was to be learned rather than on what was to be done; so 'activities' were subordinated to 'lessons'. A wide range of approaches required similarly wide access to resources, and more time for preparation. The traditional attitudes of teachers to the role of teaching were reinforced by the widely held view, not least among parents, that teachers are there to direct and control learning: 'teachers should teach'. In-service training and materials devised for curriculum development, national and local, to promote and sustain more flexible approaches had apparently made little impression on such attitudes.

Para 1.7 Textbooks are still a fundamental part of teaching in practically all subjects, and teacher-talk the principal method of exposition of their content. Worksheets, either commercially produced or devised by subject departments for their own purposes, are now in general use. The uses to which worksheets can be put are many, but, whatever their intention, teachers generally employed them to impart information and in practice as a device for class control. In the best schools the use of book and non-book materials was co-ordinated.

Para 1.12 This assessment of teaching approaches has at its centre the role of the teacher. In almost every instance, the learning activities of our pupils are dominated by it. Teacher-direction is an inescapable starting point for most formal learning, but it is also desirable to provide alternatives. All teachers are familiar with the normal range of approaches, methods, and techniques that the methodology of their specialism affords them. Much of what the survey revealed is by way of commentary on the quality of the selection made from that range, and its application, rather than a criticism

of the methods themselves.

Para 1.13 The concept of a 'subject methodology' carries with it connotations of a systematic approach to choice of methods, that the learning process may be facilitated and made more effective. It further suggests that their balance and appropriateness should be kept under review. In doing so, particular problems face teachers who work in isolation, small departments, and small schools in the remoter areas, where discussion and the sharing of experiences may be difficult. But in the great majority of schools, where such conditions are less likely to occur, there was little evidence of a positive policy for evaluating the effectiveness of teaching or resources.

Para 1.14 Methods are a sensitive issue because they are bound up with teacher attitudes and commitment to differing, and sometimes conflicting, teaching philosophies. Their evaluation is therefore not only a delicate matter; it is also extraordinarily difficult. But it is certainly possible to be objective about the use and quality of resources. In effect, this proved to be so; 'teaching' was most commonly evaluated by discussing the materials involved, and not the teaching process itself. Discussion was effective when principal teachers gave a strong lead to their departments. It tended to be lively when the applications of materials that had aroused interest and speculation formed the main topic. Thus opportunities presented themselves for broadening the discussion to include a wider evaluation of teaching strategies. To become fully effective, however, all promoted members of staff with relevant whole school or departmental responsibilities ought to be involved.

Para 1.27 Conclusion

The view of educational technology held by most teachers was relatively limited. Nevertheless some progress in its application in the classroom has undoubtedly been made in recent years. The survey revealed examples of good practice by indiviual teachers or departments involving a variety of teaching approaches, good use of resources, and effective organisation for deploying them. Good practice, however, was by no means general: provision and organisation might be adequate but it was rare to find them associated with successful innovative teaching methods; 'Good' was too frequently confused with 'more'. The management of resources is important, but as a means to an end - the efficient management of learning. School policies for the former remain relatively undeveloped, and much requires to be done to articulate them and devise strategies for implementing them. By implication, the management of the learning processes of all pupils in schools is the less effective.

B. SED(1983) Teaching and Learning in the Senior Stages of the Scottish Secondary School HMSO

Para 3.3 The objective of the Higher grade course, given equally high priority by both teachers and pupils, is to achieve the best possible results in the examination. To that end, teachers are not inclined to run risks. They prepare their work thoroughly. They teach hard and directly; to the whole class, at a brisk pace, and in a definite mould. They begin with careful exposition; they pose questions that compel brief, immediate oral responses; they give out exercises directly related to the exposition, to be done there and then, or as homework; and they assiduously mark the returns. Little time remains for diagnosis of individual strengths or weaknesses or for devising programmes for improvement or remediation.

Para 3.4 For their part, the pupils apply themselves conscientiously. They do a great deal of written work, mainly in forms and contexts that are apt to figure in the external examination; only occasionally are extended written reponses required. They are rarely involved in sustained discussion. The deadlines for their work are all fairly immediate. They are expected to take their own notes, without much guidance in advance or check afterwards. They do comparatively little background reading.

Para 3.5 Teachers and pupils are thus conjoined on a common enterprise not lightly regarded by either. The former inform, inculcate, and provide a focus for 'return'. The latter absorb, digest, and meet their deadlines. All perform thus across the curriculum, across the ability range, and irrespective of time allocations or subject pecking orders. Traditional periodic testing and preliminary examinations on the model of the external examination harden the mould.

Para 3.6 Almost all of this teaching and learning (perhaps that is the appropriate order) is, after its fashion, efficient. On the Higher grade, very good examination results are achieved as a result of class teaching, where teacher-pupil relationships are fairly formal, and if written assignments are regularly set and conscientiously marked. Significantly, such approaches do not strike all the pupils as dull; most know full well what is at stake, respect their teachers for making great efforts on their behalf, and fret only when the rigour slackens.

Para 3.7 Enlightened departures from the norm are to be found in every school, in every subject: imaginative exploitation of the timetable, the use of thematic approaches and practical applications of theoretical learning, 'research' methods, discussion periods, the use of all manner of book and non-book resources, individual study and self-assessment. Work suited to individual pupils was inevidence, although it tended to occur when classes were small and the topic practical, or with

some practical application. Tribute is due to the minority of teachers who displayed such individual enterprise. It takes exceptional resource, invention and courage to depart from a system as established and predictable as that governing the 'examination stages'. But so long as that system remains as it is at present, examples of enterprise will continue to be exceptional.

Para 3.8 Because the prevailing approaches are used on such a scale, the damage done to other effective teaching practices is serious. Dullness, from which boredom ensues, is implicit in routine methods. The absence of imaginativeness or originality calls for unusual qualities of patience and stamina in pupils and teachers alike. Motivation and enthusiasm for a subject can be permanently affected. In a good number of cases, consolidation and differentiation, both essential for successful learning, had been jettisoned as time consuming. The absence of regular discussion and oral exchange affected every aspect of the curriculum. There was a dearth of background reading, crucial to subjects like history. There was too little field work in geography, too few experiments in science. There was little extended writing to be found in any subject.

Para 3.14 CSYS embodies important educational principles. It seeks to emphasise individual investigation and enquiry, encourages less prescriptive syllabuses, and aims at a calculated balance of direct teaching, directed study, and individual endeavour. Despite all the constraints, including the absence in most schools of facilities conducive to individual study the differences between CSYS and courses leading to all other external examinations in Scottish secondary education are conspicuous. Groups are smaller and individual pupils are given more attention. Teaching approaches are more varied. Discussion is more frequent, and more extended tutorial methods are employed, individual pupils presenting papers for debate; lectures, with related note-taking, are deliberately included in many courses. There is more experimental work in science. Pupils have more responsibility for planning their work and meeting different deadlines. The decisions that require to be taken - which papers to tackle, what options to pursue, whether a topic is appropriate for a dissertation or not - prompt open discussion of the educational process and the sharing of responsibility between pupils and teachers. Teachers are extended by the syllabus. They appear to welcome the opportunity to use different approaches and cultivate aspects of their subject in which they may have a particular interest. The final comment on CSYS may have to be that it arrived too late in Scottish secondary education for it to have had a wide effect on teaching and learning generally.

Appendix II

Register of RBL Science Courses in Scottish Secondary Schools

This list although in no way claiming to be comprehensive gives an indication of the extent of RBL now in operation in Scottish schools.

Region		Page
Central		64
Fife		65
Grampian		66
Highland		68
Lothian		71
Strathclyde:	Glasgow	81
	Renfrew	85
	Dunbarton	86
Tayside		88

CENTRAL REGION

School	Class	Subject	Grade	Year Started	Comment
Alloa Academy	S3	Biology - Enzyme Unit	O	1982	Time consuming. Extra storage required
Balfron High	S2-S6	Physics			Experimental work by Word Cards is some way towards RBL
Bannockburn High	S3-S4	Foundation Science Materials Energy		1982	Partly
		Biology Physics Chemistry	O & H CSYS	1982	Small sections here and there
Bo'ness Academy	S3-S5	Chemistry	O & H	1982	Not yet at "Choice Chemistry" approach
	S3-S4	Foundation Science		1982	Use of extension material
	S3-S5	Biology	O & H	1982	To cater for very able
	S6	Biology	CSYS	1982)	Widely used due to lack of teaching time
	S6	Physics	CSYS	1980)	
Lornshill Academy	S3	Chemistry - Section 7 - Atomic Theory	O	1981	Full RBL approach
	S5	Physics - Section O Optics	H	1979	Full RBL approach

FIFE REGION

School	Class	Subject	Grade	Year Started	Comment
Balwearie H.S. Kirkcaldy	S1/S2 S3/S4	Integrated Science Choice Chemistry	0	1974 Aug '83	Open plan lab
Buckhaven H.S.	S1/S2	Integrated Science			" " "
Dunfermline H.S.	S1/S2	Integrated Science			" " "

GRAMPIAN REGION

School	Class	Subject	Grade	Year Started	Comment
Aberdeen Grammar School	S1/S2	Integrated Science		1982	Insight to Science
Bankhead Academy	S3/S4	Chemistry	O	1983	Trial of Choice Chemistry
Bridge of Don Academy	S1/S2	Integrated Science		1979	School's own system. Open plan lab for 60 pupils
Dyce Academy	S1/S2	Integrated Science		1981	"Ellon" System (modified) Open plan lab for 60 pupils
Elgin High School	S1/S2	Integrated Science		1983	School's own system Open plan lab for 60 pupils
Ellon Academy	S1/S2	Integrated Science		1979	"Ellon" System Open plan lab for 60 pupils
	S3/S4	Chemistry	O	1983	Trial of Choice Chemistry
Fraserburgh Academy	S1/S2	Integrated Science		1984	"Ellon" System
	S3/S4	Chemistry	O	1983	Trial of Choice Chemistry Open plan lab for 100 pupils

School	Class	Subject	Grade	Year Started	Comment
Gordon Schools, Huntly	S1/S2	Integrated Science		1984	Insight to Science
Inverurie Academy	S3/S4	Chemistry	0	1983	Trial of Choice Chemistry
Kemnay Academy	S1/S2	Integrated Science		1981	School's own system Open plan lab for 40 pupils plus single labs
Mintlaw Academy	S1/S2 S3/S4	Integrated Science Chemistry	 0	1981 1983	"Ellon" System Trial of Choice Chemistry Open Plan lab for 40 pupils plus single labs
Old Machar Academy	S1/S2 S3/S4	Integrated Science Chemistry	 0	1983 1983	Insight to Science Trial of Choice Chemistry Open plan lab for 60 pupils
Peterhead Academy	S1/S2	Integrated Science		1977	School's own system Open plan lab for 60 pupils
Summerhill Academy	S3/S4	Chemistry	0	1983	Trial of Choice Chemistry
Westhill Academy	S1 S2 S3/S4	Integrated Science " " Chemistry	 0	1980 1981/2 1983	"Ellon" system School's own system Trial of Choice Chemistry

HIGHLAND REGION

School	Class	Subject	Grade	Year Started	Comment
Farr Secondary	S2	Integrated Science	O	1982	Very limited experience
	S4	Biology		1982	
Golspie High	S3	Physics	O	1982	
	S4	"	O	1983	
	S5/S6	"	H	1982	
Achtercairn Secondary	S1	Integrated Science		1983	Using "Centre Science" as basis. Pleased with response and hope to continue use in S2.
	S3/S4	Science	Foundation	1981	
	S3/S4	Biology	O	1981	
Alness Academy	S3/S4	Biology	O		Interested in future use.
	S3/S4	Chemistry			
Fortrose Academy	S1/S2	Physics		1982	Early stages of involvement.
	S3/S4	Physics		1983	Using micro to store sheets.
Dingwall Academy	S3/S4	Chemistry Physics Biology	C.S.E./Foundation	1981	Limited experience
	S5	Physics	H	1983	

School	Class	Subject	Grade	Year Started	Comment
Ullapool Secondary	S1/S2	Integrated Science			Very limited involvement,
	S3/S4	Foundation Science			hope to do more.
Charleston Academy	S3	Chemistry	O	1983	- Choice Chemistry in use.
	S3	Biology	O	1983	Trialled one topic.
Culloden Academy	S1/S2	Integrated Science		1982	Fully operational using "Insight to Science".
	S3/S4	Physics	O	1981	
		Biology	O	1982	School produced materials.
		Chemistry	O	1983	Choice Chemistry being used.
		Science	Foundation	1982	Hope to extend to General.
Plockton High	S3/S4	Physics	O	1980	
	S5	"	H	1980	
	S3	Biology	O	1981	
	S5	Biology	H	1981	
Inverness Royal Academy	S3/S4	Biology	O	1983	Trial section on Reproduction
	S5/S6	Physics	H	1982	Section P & R of syllabus
	S3/S4	Science	Foundation	1982	Tried with few topics

School	Class	Subject	Grade	Year Started	Comment
Lochaber High	S1	Integrated Science		1983	Have decided to adopt approach for S1/S2.
	S3/S4	Science	Foundation	1982	Used in some Topics.
	S3/S4	Chemistry	O	1983	- Trying out approach for first time.
			H		
	S3/S4	Biology	O	1982	Developing course.
	S3/S4	Physics	O	1982	" "
	S5	"	H	1981	Only option section tackled this way.
Tain Royal Academy	S3/S4	Physics	O	1982	Not with all classes.
Invergordon Academy	S3	Physics	O	1983	Very limited experience so far.
	S5	Physics	H	1983	
Nairn Academy	S5	Biology	H	1982	- Have tried with some sections of Science in S1 to S4.

LOTHIAN REGION

School	Class	Subject	Grade	Year Started	Comment
Dunbar Grammar	S3	Biology	O	1983-84	Need for pool of available materials - a particular support requirement for small schools or departments
Knox Academy	S1	Physics		1982	
	S1	Chemistry		1983	
	S2	Physics		1983	
	S2	Chemistry		1983	
	S4	Physics	O	1981	Heat, Section K only
	S5	Physics	H	1983	Mechanics, Section N only
	S6	Physics	CSYS	1983	
Musselburgh Grammar	S3/ S4	Physics	O	Aug 1982	Lothian Region working group materials
North Berwick High	S2	Chemistry		1981	
	S3/S4	Chemistry	O/CSE	1981	Choice Chemistry materials
Preston Lodge High	S3/S4	Physics	O		
	S3/S4	General Science	CSE	1981	Not self pacing
	S3/S4	Foundation Science		1982	Only individualised at General Level
	S3/S4	Biology	O	1981	Certain topics only
Ross High	S3/S4	Biology	O	1983	Only some of the 'O' topics

School	Class	Subject	Grade	Year Started	Comment
Dalkeith High	S6	Biology	CSYS	1980	Mainly guidance through Textbook materials
	S5	Physics	H	1981	Units on electricity and mechanics (now due to be updated for new syllabus) Each unit designed to be completed in 2 periods - reading and problems at home - work in school usually lab work
	S3/S4	Physics	O	1982	'Top 40' pupils selected. 20 use Lothian working party RBL materials other 20 taught conventionally
	S1/S2	Integrated Science		1982	Sections 4 and 7 in format suitable for RBL
Lasswade High	S3/S4	Chemistry	O	1982	'Choice' Chemistry
	S3/S4	Biology	O	1980	Revised in 1982 - own course
	S3/S4	Biology	CSE	1982	
Newbattle High	S3/S4	Biology	O/CSE	Aug 1982	Development will be complete in March 1984
Penicuik High	S3/S4	Biology	O	1983	Development proceeding
St David's High	S3	Chemistry	O	1976	
	S4	Chemistry	O	1976	
	S5	Chemistry	H	1977	
	S3/S4	Biology	O	1983	Only a few topics
	S3/S4	Physics	O	1981	
	S1/S2	Integrated Science		1983	S1 only - S2 to follow in 1984
Blackburn Academy	S1/S2	Integrated Science		1982	
	S3/S4	Physics	O	1978	Some Higher materials produced
	S3/S4	Biology	O	1983	Development proceeding

School	Class	Subject	Grade	Year Started	Comment
Broxburn Academy	S5/S6	Physics	O	1980/81	Used for 1 year O grade course. Has been used with S3/S4 O grade
	S5/S6	Chemistry	O/CSYS	1981-82	Used for 1 year O grade course. CSYS course is the ILPAC independent learning for A level chemistry
Craigshill	S3/S4	Biology	O	1978	An internally devised system, not strict Keller plan. Covers almost the whole O grade course.
James Young High	S1/S2	Integrated Science		1982	
	S3/S4	Physics	O/CSE	1982	
	S3/S4	Chemistry (Choice)	O/CSE	1982	
	S3/S4	Biology	O/CSE	1982	
Deans Community High	S3/S4	Physics	O	1980	
	S3/S4	Science	CSE	1980	
	S1/S2	Integrated Science		1979	
	S3/S4	Biology	O	1979	
	S3/S4	Child Care	CSE	1980	
	S3/S4	Chemistry	O	1980	Full set of core sheets available. Extension work not developed due to M/D implementation. Unit test available for the 27 units. Team teaching being tried in S4 at present.
Our Lady's High	S3/S4	Biology	O	1980	Based on Strathclyde Biology Group 'Science of Life' books

School	Class	Subject	Grade	Year Started	Comment
Inveralmond Community High	S1/S2	Integrated Science		1979	14 Units based on CP7 and SWP Internally generated materials (RBL) Core - extension model throughout Current developments in graded extension/ multi-level assessment
	S3/S4	Biology	O/CSE	1979	25 Units, core set at CSE (grade 1-5 assessment) Optional work 'O' grade: Unit tests; wordlists and objectives. Course is individualised RBL.
	S3/S4	Human Biology	CSE	1980	15 Units, core set at CSE (Grades 2-5) Optional work set at CSE grade 1, Unit tests, wordlists and objectives, course is individualised RBL
	S3/S4	Science	CSE	1979	12 Units internally developed basic core model throughout set at grade 1-5 RBL
	S3/S4	Choice Chemistry	O/CSE	1980	'Choice Chemistry' 10 Units, core and extension model. Extensions graded. Multi-level tests. Micromodules. Self contained micro-units.
	S3/S4	Physics	O/CSE		Several trial units written from S3 work. Intention to have core + extension for General/Credit level. Check tests, end of topic tests, homeworks etc.
St Mary's High	S1/S2	Integrated Science		Aug 1982	Commercially produced sheets used. Need to be drastically re-written in the light of experience. Expect the course to be well settled by Aug 1985.
	S3	Biology	O/CSE	1984	Hope to do part RBL in third year as this is the first year of S3 who will have been wholly taught in S1 and S2 by RBL. Accommodation is a major problem.

School	Class	Subject	Grade	Year Started	Comment
Ainslie Park High	S1	Integrated Science		1981	Prior to 1981 the S1 classes were housed in an annexe with individual classrooms housing the separate sections. In 1981 S1 was moved to main school with open plan science accommodation, which facilitated the use of RBL.
	S2	Integrated Science		1977	With the opening of the new science block with open plan accommodation, RBL was introduced and is working successfully
	S3/S4	Chemistry	O/CSE	Aug 1982	Choice Chemistry course introduced to present S4 and continued with present S3. Although the chemistry lab is small and a seminar room is used as a reference base the RBL course is working very satisfactorily.
	S3/S4	Biology	O/CSE	1982	This year (Jun 84) will be the first presentation of this course developed in this Dept. Previous to this development we spent about 2 years phasing in and generating new materials.
Balerno High	S1/S2	Integrated Science		1983	Ongoing development
	S3/S4	Chemistry	O	1980	Choice Chemistry Multilevel, as per G and C models
	S3/S4	Biology	O	1981	At present one level, to be changed to 2 as and when G and C come into force.
Boroughmuir High	S1	Integrated Science		1981	Development proceeding
	S2	Integrated Science		1984	
	S3/S4	Biology	CSE	1982	
	S3/S4	Science	CSE	1982	

2.5
2.2
2.0
2.8
3.2
3.6
4.0
1.0
1.1
1.25
1.4
1.6
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School	Class	Subject	Grade	Year Started	Comment
Broughton High	S3 and part of S4	Biology	O/CSE	1981/2	Development still proceeding with the aim of improving current sections and increasing number units in S4 Dual presentation (O and CSE) is available for candidates from 1984
	S1/S2	Science (Integrated)		1980/1	Many sections are resource based. More are in the process of revision.
	S3/S4	Chemistry	O/CSE	1980/1	Choice Chemistry. Dual presentation.
Castlebrae High	S3/S4	Chemistry	O	1979	
	S3/S4	Physics	O	1980	
	S1/S2	Integrated Science		1980	Although teaching material is available S1/S2 classes are generally not taught entirely using RBL method
Craigroyston High	S3/S4	Physics	O	1982	All units, etc are complete. However we are still not fully operational due to an equipment storage and distribution problem
	S1/S2	Science		1981-2	Although not strictly RBL each pupil is catered for individually through diagnostic testing, remediation and extension work where appropriate.
	S3/S4	Biology	O	1982	Units prepared on Classification, Water 1, Water 11, Photosynthesis, Food and feeding. Enzymes, Size & Shape, Genetics. These still are in need of some revision but have been used with 2/3 groups of pupils.

School	Class	Subject	Grade	Year Started	Comment
Craigmount High	S1	Integrated Science		1983	
	S2	Physics		1980	
	S3/S4	Chemistry	O/CSE	1982	
	S3/S4	Physics	O/CSE	1982	
	S3/S4	Biology	O/CSE	1982	
	S5	Biology	H	1984	Development proceeding
	S6	Chemistry	CSYS	1984	Development proceeding
Drummond High	S3/S4	Physics	O	1982	
	S3/S4	Chemistry	O/CSE	1981	Choice Chemistry materials
Firrhill High	S2	Integrated Science		1981	Multilevel RBL for mixed ability teaching groups. Assessment is based on criterion ref. multilevel testing.
	S3/S4	F/G Science	F/G	Jan 1984	Just started developing philosophy, assessment techniques, content etc.
	S3/S4	Choice Chemistry	O/CSE	1980	Part of 'Choice Chemistry' development project, with a view to presentation at Credit and General level for the top 80% of the ability range. Multilevel RBL approach with end of the unit tests based on CR assessment.
	S3/S4	Physics	O/CSE		RBL mediumpaced core for all pupils-extensions for high ability pupils being developed.
	S5	Physics	H		A few units have been produced for the new H grade. More being produced on ad hoc basis.

School	Class	Subject	Grade	Year Started	Comment
Forrester High	S1	Integrated Science		1982	Regarded as a success by majority of staff
	S2	Integrated Science		1983	
	S5/S6	Physics	H	1978	Being completely rewritten 1983/4
	S5/S6	Physics	O	1980	Students wishing to take O in one year - using St Augustine's course as we have not written an O course of our own
	S6	Physics	CSYS	1979	Composite classes of S5/S6 for any 2 (as required) of O, H, CSYS have been made possible and have been successfully run. We have not had a composite class of all 3, as it was considered to be too demanding on teachers.
Holy Rood High	S1/S2	Integrated Science		1974/75	
	S3/S4	Chemistry	O	1974/75	Some Higher materials
	S3/S4	Biology	O	1978/79	Some Higher materials
	S3/S4	Physics	O and H	1973/74	
	S3/S4	Science	CSE	1978/79	
Leith Academy	S1/S2	Integrated Science		1982	
	S3/S4	Physics	O	1982	
Portobello High	S1/S2	Integrated Science		1982	
	S3/S4	General Science	CSE	1983	
Trinity Academy	S1/S2	Integrated Science		1982	Commercially produced materials

School	Class	Subject	Grade	Year Started	Comment
St Augustine's High	S1/S2	Integrated Science		1980	
	S3/S4	Biology	O/CSE	1981)	Dates apply to learning materials at present in use. These schemes are developments of work that originated in early 70s.
	S3/S4	Chemistry	O/CSE	1982)	
	S3/S4	Physics	O	1982)	
Queensferry High	S3/S4	Biology	O	1983	Food, Feeding, Digestion, Photosynthesis, Ecology
	S1/S2	Integrated		1981/82	
The Royal High	S5	Chemistry	H	1983	First Twenty Elements Section
	S1	Integrated Science		1982	Section 7
	S2	Integrated Science		1983	Section 13
					+ development in other 1st and 2nd year areas
St Thomas' High	S2	Integrated Science		1983/84	S1 - 84-5 intended
	S3/S4	Physics	O	1980	Lothian Working Party units
	S3/S4	Physical Science	CSE	1983	Part of the above units
	S5	Physics	H	1980	Part of course
Tynecastle High	S1	Integrated Science		1982	Only units 2, 3 and 4, possibility of 6
	S2	Biology	O	1982	All topics in S2 Biology can be taught by the RBL method
	S3/S4	Biology	O	1983	Start has been made with a few units
	S2	Physics		1983	
	S3	Physics		1978	
	S4	Physics		1977	
	S5	Physics	H	1976	
	S6	Physics	CSYS	1978	

School	Class	Subject	Grade	Year Started	Comment
Wester Hailes Education Centre	S1/S2	Integrated Science		1978	Core and Extension Model. A, B and C extension hierarchical, A - reinforcement of core, B - include any content of A + extend core, C - include any content of A and B + application. Each core followed by 10 item self assessment. End of unit multilevel test. (Quick Quiz).
	S3/S4	Biology	O/CSE	1979	Core booklets - CSE level material. Each core between 3-6 topics (self-assessment after each topic). Two level extension B ⇒ CSE, C ⇒ O grade & AB (Operational video available)
	S3/S4	Physics	O/CSE	(1980) 1982	
	S3/S4	Chemistry	O/CSE	1980	Choice Chemistry - run as Integrated Science above.

STRATHCLYDE REGION/ GLASGOW DIVISION

School	Class	Subject	Grade	Year Started	Comment
Albert Sec.	S1 S3/4	Integ. Sc. Biology	 O	1983 1980	
Lourdes Sec.	S3/4	Biology	O	1980	
Lochend Sec.	S1/S2	Integ. Sc.		1980	
Bellahouston Sec.	S3/4/5/6	Biology	O H	Pre 1979	
Hillhead Sec.	S3/4	Biology	O	1980	
St. Andrew's	S3/4	Biology	O	1983	
St. Mungo's	S3/4	Biology	O	?	

School	Class	Subject	Grade	Year Started	Comment
Hyndland Sec.	S1/S2	Integ. Sc.		?	
Glenwood Sec.	S1/S2	" "		1979	
Bannerman H.S.	S3/S4	Biology	O	?	
Eastbank Academy	S3/S4	Biology, Found Sc.	O		
Waverley Sec	Poss S3/S4	Biology	O	?	
Whitehill Sec.	S1/S2	Integ. Sc.		1978	Using own materials. Previously used NWP sheets
" "	S3/S4	Chemistry) Physics)	O	1979	Keller plan using long term self-pacing
" "	S5/6	Biology)	H	1981	Still developing. Using medium term self-pacing
" "	S3/4	Science	Foundation	1979	Still developing

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School	Class	Subject	Grade	Year Started	Comment
Penilee Sec.	S3/S4	Chemistry	O	1980	
" "	S5/S6	Chemistry	H	1980	
Glenwood Sec.	S1/2	Integ. Sc.		1980	Using own materials
" "	S3/4	Chemistry	O	1981	
" "	S5/6	"	H	1983	
Lochend Sec.	S1/2	Integ. Sc.		1981	
Possilpark Sec.	S1/2	Integ. Sc.		1980	Using NWP sheets with additional differentiated materials
" "	S3/4	Chemistry	O	1980	Own materials
" "	S5/6	Chemistry	H	1983	

School	Class	Subject	Grade	Year Started	Comment
John Street Sec.	S3	Foundation	Foundation		
" " "	S3-S5	Physics	O & H	1980	
" " "	S3-S4	Biology	O	1982	
" " "	Poss S1-S2	Integrated Science		1982	New PT Biology at school trying to establish RBL in integrated science.
Cathkin H.S.	S5	Physics	H	1980	
Cranhill Sec.	S3	Chemistry	O	1983	
" "	S3-S4	Biology	O	1982	
" "	S3-S5	Physics	O & H	1980	

STRATHCLYDE REGION/RENFREW DIVISION

School	Class	Subject	Grade	Year Started	Comment
John Neilson H.S. Paisley	S3-S5	Physics	O&H	1980 (approx)	
Renfrew H.S.	S3-S5	Biology	O&H	1982	
Williamwood H.S. Clarkston	S3-S5	Chemistry	O&H	1981	(Not happening throughout dept)
St. Columbas H.S. Gourock	S3-S5	Chemistry	O&H	1982 (approx)	Use home-made audio tapes extensively
Cowdenknowes H.S.	S1-S2	Integrated Science		1982	Early stages of dept. experiment

STRATHCLYDE REGION/DUNBARTON DIVISION

School	Class	Subject	Grade	Year Started	Comment
Abronhill H.S. Cumbernauld	S3/S4	Chemistry	O	1982	
Boclair Ac. Bearsden	S3/S4/S5	Physics	O&H	1980	
" " "	S2	Integ. Sc.		1982	
Chryston H.S.	S1/S2	Integ. Sc.		1982	
" "	S3/S4	Chemistry	O	1983	
" "	S3/S4	Physics	O	1982	
Cumbernauld H.S.	S1/S2	Integ. Sc.		1982	
	S3/S4	Chemistry	O	1982	
Greenfaulds H.S.	S3/S4	Chemistry	O	1982	
" "	S3/S4	Physics	O	1982	
" "	S1	Integ. Sc.		1983	
Hermitage Ac.	S1/S2	Integ. Sc.		1982	

School	Class	Subject	Grade	Year Started	Comment
Kilsyth	S3	Chemistry	O	1983	
Kirkintilloch	S3/S4	Foundation Sc.		1982	
Our Lady's H.S.	S5/S6	Physics (Electronics)	H & CSYS	1982	
St. Maurice's	S1	Integ. Sc.		1982	
	S3/S4	Chemistry	O	1982	
Thomas Muir	S3/S4	Foundation Sc.		1982	
" "	S1	Integ. Sc.		1983	
Vale of Leven Ac.	S1	Integ. Sc.		1983	

TAYSIDE REGION

School	Class	Subject	Grade	Year Started	Comment
Craigie High	S1/S2	Science	Foundation	1983	At a very early stage
	S3/S4	Science			
	S3/S4	Biology & Chemistry			
Perth High	S5	'H' Chemistry - Section 20 (Reaction Kinetics)		1983	Aim to compare results with those achieved by "conventional" teaching
	S4	Physics - Heat Section	O	1983	Looks very promising
	S2	Physics - Heat, Sound		1982	Well tried and is successful

Appendix III

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